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PICATINNY ARSENAL TECHNICAL DIVISION



TECHNICAL REPORT

SUBJECT: Evaluation of 70/30 Cyclotol and 75/25 Cyclotol
for Use in HE and HEAT Projectiles

PROJECT NO. EP-14

REPORT NO. 1

PREPARED BY: Louis Jablansky

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OBJECT

To evaluate 70/30 Cyclotol and 75/25 Cyclotol for use as bursting charge explosives in HE and HEAT ammunition.

SUMMARY

The Holston Defense Corporation developed a process for manufacturing 75/25 Cyclotol which in the molten state is sufficiently fluid to be loaded with the equipment and by the methods now used for melt-loading Composition B. As the great potential energy of 75/25 Cyclotol was thought to be advantageous for increasing the effectiveness of HE and HEAT ammunition, tests were made to evaluate it, and 70/30 Cyclotol made from it by adding TNT, for these types of ammunition.

It was found in static tests that 3.5 Inch HEAT Rocket Heads containing 75/25 Cyclotol bursting charges penetrated on the average 14.7 to 14.9 inches of mild steel, and similar heads containing 70/30 Cyclotol bursting charges penetrated 14.3 and 14.4 inches of mild steel in parallel tests; whereas 3.5 Inch Rocket Heads containing Composition B penetrated 14.2, 14.4, and 14.6 inches of mild steel under the same or similar conditions. Similar differences in steel-penetrating ability were found in static tests of 105 mm M324 HEAT Shell containing bursting charges of 75/25 Cyclotol, 70/30 Cyclotol, and Composition B, respectively.

In pit fragmentation tests of 90 mm M71 HE Shell, 75/25 Cyclotol-loaded shell produced approximately 1,500 fragments as compared with 1,350 fragments for 70/30 Cyclotol-loaded shell and 1,100 fragments for Composition B-loaded shell. In pit fragmentation tests of 105 mm M1 HE Shell, 75/25 Cyclotol-loaded shell produced approximately 2,330 fragments as compared with 2,470 and 2,070 for 70/30 Cyclotol-loaded shell and Composition B-loaded shell, respectively.

70/30 Cyclotol as manufactured by dilution of 75/25 Cyclotol with TNT was equivalent in viscosity to Grade A Composition B. 75/25 Cyclotol was much more viscous than 70/30 Cyclotol or Grade A Composition B and difficulty was experienced in obtaining good castings in some ammunition items.

In a large impact drop test, cast 75/25 Cyclotol was found to be slightly more sensitive to impact than cast Composition B, which in turn was slightly more sensitive than cast 70/30 Cyclotol. All three explosives had essentially the same sensitivity to rifle bullet impact.

In 100°C and 120°C Vacuum Stability Tests (40 hours each) there was less than 3/4 ml of gas evolved in each test for 75/25 Cyclotol and 70/30 Cyclotol.

CONCLUSIONS

The ability of non-rotated HEAT ammunition to penetrate steel can be

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increased slightly, possibly 2 to 3 per cent, by loading the metal parts assemblies with 75/25 Cyclotol instead of Composition B. The small advantage gained, however, may be offset by greater difficulty in meeting density and cavity standards due to the higher viscosity of molten 75/25 Cyclotol as presently manufactured.

There is no apparent advantage in replacing Composition B with 70/30 Cyclotol made from 75/25 Cyclotol as the explosive filler for HEAT rounds.

The effectiveness of ammunition designed for fragmentation effect can be increased by loading the metal parts assemblies with 75/25 Cyclotol or 70/30 Cyclotol instead of Composition B. The greater potential effectiveness of 75/25 Cyclotol may be offset by difficulty in loading, which would render 70/30 Cyclotol a good compromise from the production point of view.

RECOMMENDATIONS

It is recommended that:

- a. 75/25 Cyclotol (as presently manufactured at Holston Ordnance Works) not be used in shaped charge items except where the slight gain in penetration is considered absolutely necessary.
- b. 70/30 Cyclotol not be used to replace Composition B in shaped charge items.
- c. 70/30 Cyclotol be considered favorably for use as the HE filler in fragmentation type shell and fragmentation bombs.
- d. Studies be continued to develop low viscosity cyclotols of high RDX content.

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INTRODUCTION:

1. In 1950 the Holston Defense Corporation developed a process for manufacturing highly fluid RDX/TNT mixtures (cyclotols) containing up to 75 per cent of RDX, and produced approximately 12,000 pounds of 75/25 Cyclotol in 100-pound batches. This was an important advance in explosives technology as it made possible the use of ordinary melt-loading techniques for preparing 70/30 Cyclotol and 75/25 Cyclotol charges. 75/25 Cyclotol made prior to this had been too viscous in the molten state to be pourable.

2. The process employed is described in detail in Reference A. It involved production of coarse equant RDX crystals by recrystallization from cyclohexanone, melting and recasting Composition B taken from wartime stocks to reduce its apparent viscosity, and then incorporation of the coarse RDX crystals with the recast Composition B and TNT in the proportion of 60:25:15 in the same manner as RDX and TNT are combined in the manufacture of Composition B.

3. As the great potential energy of 75/25 Cyclotol was thought to be advantageous for increasing the effectiveness of HE and HEAT ammunition, the development of a potential source of supply of this explosive led to an extensive investigation of its properties and behavior in several standard Ordnance projectiles. The initial work was conducted with 3,000 pounds of 75/25 Cyclotol from the 12,000-pound lot (Lot HOL-E-5-1) referred to in Paragraph 1. Additional quantities from other lots were obtained subsequently. The study included the tests proposed in Reference B to evaluate 75/25 Cyclotol and 70/30 Cyclotol in comparison with Composition B for use as explosive filler for the 3.5 Inch M28A2 Rocket, and the tests authorized in Reference C, which were intended to establish whether 75/25 Cyclotol has sufficient merit for use in the 105 mm HE M1 Shell to warrant more extensive testing.

4. This report was prepared to gather under one cover the information obtained to date at this Arsenal in tests made to evaluate the Holston 75/25 Cyclotol and 70/30 Cyclotol made by diluting the 75/25 Cyclotol with TNT.

RESULTS:

5. The viscosity of the 75/25 Cyclotol of Lot HOL-E-5-1 in a molten state varied from box to box over the range of 9 to 14 seconds at 85°C in tests by the efflux method currently used in acceptance tests of Composition B. The viscosity of 70/30 Cyclotol made from the 9-second 75/25 Cyclotol by adding TNT was approximately 5 seconds. While even the most viscous 75/25 Cyclotol tested was pourable at 87° to 89°C, some difficulty was experienced in melt-loading this material into 2.36 Inch Rocket Heads and shell because it tended to entrap air and did not flow well into narrow regions in the charge cavity. These difficulties were not encountered in melt-loading the 70/30 Cyclotol.

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6. The steel-penetrating ability of 3.5 Inch M28A2 HEAT Rocket Heads containing explosive charges of 75/25 Cyclotol, 70/30 Cyclotol, Composition B, and 50/50 Pentolite respectively, was determined in several series of static tests. The data pertaining to each test are presented in Table I. The following is a summary of the results of these tests:

<u>Metal Parts Lot HB 1-39</u>	<u>75/25 Cyclotol</u>	<u>70/30 Cyclotol</u>	<u>Composition B</u>	<u>50/50 Pentolite</u>
Number of tests			10	
*Penetration, inches, avg			14.4	
Penetration, inches, max			15.1	
Penetration, inches, min			13.0	
Standard deviation, inch			0.65	
<u>Metal Parts Lot HB 1-42</u>				
Number of tests	12	12	10	
*Penetration, inches, avg	14.7	14.3	14.2	
Penetration, inches, max	15.2	15.0	15.1	
Penetration, inches, min	13.8	13.2	13.1	
Standard deviation, inch	0.36	0.52	0.56	
Density of explosive charge, gm/cc, average			1.699	
<u>Metal Parts Lot HB 1-74</u>				
Number of tests	13	14	13	15
*Penetration, inches, avg	14.9	14.4	14.6	13.7
Penetration, inches, max	16.1	15.7	15.6	15.0
Penetration, inches, min	13.8	12.9	13.5	12.4
Standard deviation, inch	0.63	0.79	0.62	0.75
Density of explosive charge, gm/cc, average	1.699	1.699	1.673	1.657

7. The steel-penetrating ability of 2.36 Inch T59E3 HEAT Rocket Heads containing explosive charges of 75/25 Cyclotol, 70/30 Cyclotol, Composition B, and 50/50 Pentolite, respectively, was determined in static tests. The results of each test are presented in Table II. The following is a summary of the data:

	<u>Number of Tests</u>	<u>Penetration** of Target (inches)</u>			
		<u>Avg</u>	<u>Max</u>	<u>Min</u>	<u>Std Deviation</u>
<u>75/25 Cyclotol</u>					
First group	15	8.4	11.5	6.4	1.61
Second group	10	10.1	13.2	6.7	1.99

*Depth of hole formed in mild steel target. Standoff was 4.2 inches.

**Depth of hole formed in mild steel target. Standoff was 4.8 inches.

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	<u>Number of Tests</u>	Penetration** of Target (inches)				<u>Std Deviation</u>
		<u>Avg</u>	<u>Max</u>	<u>Min</u>		
70/30 Cyclotol						
First group	15	9.8	11.9	8.0	1.16	
Second group	10	11.3	12.7	9.0	1.03	
Composition B	15	10.1	12.0	7.8	1.05	
50/50 Pentolite	10	10.3	12.1	6.5	1.72	

8. The steel-penetrating ability of 105 mm M324 (T43) HEAT Shell containing explosive charges of 75/25 Cyclotol, 70/30 Cyclotol, and Composition B, respectively, was determined in static tests. The results of these tests are presented in Table III. The following is a summary of the data:

	<u>Number of Tests</u>	Penetration * of Target (inches)				<u>Std Deviation</u>
		<u>Avg</u>	<u>Max</u>	<u>Min</u>		
75/25 Cyclotol	3	23.0	23.3	22.6	0.61	
70/30 Cyclotol	11	22.0	23.5	21.1	0.69	
Composition B	10	22.2	23.1	21.0	0.73	

9. Pit fragmentation tests of 90 mm M71 and 105 mm M1 HE Shell containing bursting charges of 75/25 Cyclotol, 70/30 Cyclotol, and Composition B, respectively, were conducted to determine the relative effectiveness of these explosives in projectiles designed for fragmentation effect. The fragments from typical shell in the six groups of tests are shown in the inclosed photographs (M-38643, M-38968, M-31219, M-39454, M-39458, and M-39456, in order of caliber and kind of bursting charge). The data from all the tests except those of the 90 mm shell containing Composition B are presented in the inclosed fragmentation test record sheets. The data from the tests of the 90 mm Composition B-loaded Shell are presented in Reference D. The following is a summary of the pit fragmentation test results:

**Depth of hole formed in mild steel target. Standoff was 4.8 inches.

* Depth of hole formed in mild steel target. Standoff was 6.5 inches. The loaded shell were not rotated during these tests.

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<u>Number of Tests</u>	<u>Density of Explosive Charge (gm/cc, average)</u>	<u>Fragments Retained on No. 4* Screen</u>				<u>Percent of Original Metal Recovered</u>
		<u>Total Number</u>	<u>Avg</u>	<u>Max</u>	<u>Min</u>	
90 mm M71 Shell						
75/25 Cyclotol	10	1.72	1514	1604	1448	96.7
70/30 Cyclotol	10	1.71	1357	1457	1280	96.7
Composition B	8	--	1104	1153	1066	97.7
105 mm M1 Shell						
75/25 Cyclotol	10	1.70	2331	2595	2169	95.8
70/30 Cyclotol	10	1.69	2465	2595	2291	96.2
Composition B	10	1.67	2065	2280	1697	97.0

10. One hundred 105 mm M1 Shell were loaded with 75/25 Cyclotol of Lot HOL-E-5-1 for proving ground tests in comparison with 105 mm M1 Shell containing Composition B. Ninety-five of the shell containing 75/25 Cyclotol have been tested to date. The results of these tests are recorded in Jefferson Proving Ground Firing Record No. 144531, copy inclosed. The following tests were made:

Safety Test - Fifty rounds with inert fuze and with propelling charge adjusted to give a pressure of about 36,400 psi were conditioned at 70°F and then fired for graze impact.

High temperature test - Fifteen rounds with inert fuze and with normal propelling charge were conditioned at 160°F and then fired for graze impact.

Functioning at various temperatures test - Ten rounds with live fuzes were conditioned at 70°F and then fired for graze impact. This test was repeated with two groups of 10 rounds each, one group having been conditioned at -40°F, and the other at 125°F, and maintained at these temperatures until just before being fired.

No malfunctioning was noted in any of these tests.

* No. 4 sieve was used in accordance with standard procedure, since these fragmentation tests were performed prior to information that smaller than 4-mesh fragments are significant in fragmentation.

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11. The detonation velocity of cast 75/25 Cyclotol, 70/30 Cyclotol and Composition B charges having densities approximately the same as those of the explosive charges in the fragmentation and steel-penetration tests were determined by two methods, one involving a rotating drum camera, the other a Potter Counter Chronograph. The individual values from these tests are given in Table IV. The averages of the values are:

	<u>Density of Charge (gm/cc)</u>	<u>Rate of Detonation (meters per second)</u>	
		<u>Potter Chronograph</u>	<u>Drum Camera</u>
75/25 Cyclotol	1.70	8035	
	1.71		7938
70/30 Cyclotol	1.69		7893
	1.70	7919	
Composition B	1.67	7770	
	1.69		7827

12. The sensitivity of cast charges of 75/25 Cyclotol, 70/30 Cyclotol and Composition B was determined by rifle bullet and falling weight tests. The following results were obtained in these tests:

RIFLE BULLET TESTS

Data for Standard^a Test

	<u>Composition B (Lot HOL-3-6)</u>	<u>70/30 Cyclotol Lot No.^b</u>	<u>75/25 Cyclotol Lot HOL-E-5-1</u>
<u>Type of Action</u>	<u>Test No. 1 No. of Actions in 10 Trials</u>	<u>Test No. 2 No. of Actions in 10 Trials</u>	<u>No. of Actions in 10 Trials</u>
Unaffected	1	7	1
Smoke	5	2	5
Burning ^c	2	0	0
Low Order ^d	0	1	4
High Order	2	0	0

^a - Standard bombs require standard black iron pipe nipple 2" diameter x 3" length with standard threaded caps

^b - 70/30 Cyclotol made by diluting 75/25 Cyclotol (HOL-E-5-1) with TNT

^c - Low Order = Explosion occurs but some explosive remains after the reaction

^d - High Order = Explosion occurs but no explosive remains after the reaction

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Data for Modifieda Test

Type of Action	Composition B (Lot HOL-3-6)				70/30	75/25
	Test No. 1 No. of Actions in 10 Trials	Test No. 2 No. of Actions in 10 Trials	Test No. 3 No. of Actions in 10 Trials	Test No. 4 No. of Actions in 10 Trials	Cyclotol Lot No.	Cyclotol Lot HOL-E-5-1
Unaffected	1	2	1	1	0	0
Smoke	4	6	3	7	2	3
Burning	4	0	0	0	1	0
Low Order ^b	1	2	5	2	6	7
High Order ^c	0	0	1	0	0	0

Falling Weight Tests

Firing Caused by 100-kg Weight
Falling (feet)*

75/25 Cyclotol

Test #1
Test #2

2
1½

70/30 Cyclotol

Test #1
Test #2
Test #3

2½
2½
2½

Composition B

Test #1
Test #2

2
2½

13. Samples of 75/25 Cyclotol and 70/30 Cyclotol were subjected to the 100°C and the 120°C Vacuum Stability Tests. The results are presented in Chemical Laboratory Report No. 137460, copy inclosed. The amount of gas liberated from a 5-gram sample in 40 hours in these tests did not exceed 0.75 milliliter.

^a - Modified bombs (Dwg PX-7-638)

^b - Low Order = Explosion occurs but some explosive remains after the reaction

^c - High Order = Explosion occurs but no explosive remains after the reaction

*Minimum height of fall at which at least one detonation or burning occurred in 10 trials, each with a new sample of explosive.

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DISCUSSION OF RESULTS:

14. The viscosity of the 75/25 Cyclotol in a molten state did not receive much attention at first as the first few boxes of Lot HOL-E-5-1 opened apparently contained low-viscosity material and no difficulty was encountered in loading either it, or the somewhat more fluid 70/30 Cyclotol made from it. Viscosity determination made early in the study gave the following results:

Test No.	75/25 Cyclotol		70/30 Cyclotol		Comp B*	
	1	2	1	2	1	2
Viscosity at 81°C, efflux seconds	10.6	11.6	5.7	5.6	5.7	5.6
Viscosity at 85°C, efflux seconds	8.7	8.8	4.6	4.7	4.8	4.9
Viscosity at 88°C, efflux seconds	7.4	7.8	4.1	4.2	4.2	4.1

15. A few months later when 105 mm M1 HE Shell were being loaded with 75/25 Cyclotol of Lot HOL-E-5-1, it was noted that the molten explosive was very viscous and that a great many small air bubbles were entrapped in the bursting charge when it solidified. A great many of these shell were rejected when they were inspected as the cavities present exceeded the limits set by Specification No. 50-15-5D (Loading of HE Shell with TNT, 50/50 Amatol, and Composition B, Casting Methods, Assembling and Packing). Viscosity measurements made on the 75/25 Cyclotol being used at that time gave erratic results ranging for one sample from 13.9 to 17.6 seconds and for another from 10.1 to 13.8 seconds, all at 85°C.

16. The viscosity of the 75/25 Cyclotol in use during the loading of the 3.5 Inch Rocket Heads was apparently fairly low as no serious loading problems were encountered. But during the loading of the 105 mm M324 HEAT Shell, the high viscosity of the 75/25 Cyclotol resulted again in rejection because of excessive amounts of entrapped air in the explosive charges.

17. In attempting to solve the problem of loading the high-viscosity 75/25 Cyclotol satisfactorily the number of pours, pouring temperature, and stirring technique were varied. Keeping the melting and pouring temperature between 86° and 90°C seemed to be beneficial. From the following data it was concluded that holding the molten explosive at this temperature has little effect on the viscosity.

*Lot HOL-3-6

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Viscosity at 85°C
(efflux seconds)

75/25 Cyclotol* immediately after melting	14.5
75/25 Cyclotol maintained at 86°C for 1 hour	14.0
75/25 Cyclotol maintained at 86°C for 2 hours	14.5
75/25 Cyclotol maintained at 86°C for 3 hours	14.0

18. Further work is required to establish whether the viscosity of 75/25 Cyclotol has a marked effect on the viscosity of 70/30 Cyclotol made from it by adding TNT. At present it is known only that the 70/30 Cyclotol used in the experiments described in this report was sufficiently fluid to be loaded readily.

19. From the summaries of data in Paragraphs 6, 7, and 8 it is judged that use of 75/25 Cyclotol as presently manufactured in place of Composition B as explosive filler for HEAT ammunition would yield little if any improvement in performance at the target, and that no improvement would be derived from the use of 70/30 Cyclotol. In the tests made with 3.5 Inch Rocket Heads and 105 mm M324 Shell as test media the performance of 75/25 Cyclotol was 2 to 3.6 per cent better, as judged from the averages of the depth of penetration values, than that of Composition B. The 2 per cent difference was in the series in which 3.5 Inch Rocket Heads of metal parts Lot No. HB-1-74 was the test medium. The 3.6 per cent difference was in the series of tests with the 105 mm M324 Shell. The fact that the mass of metal surrounding the explosive charge in the M324 Shell is much greater than that around the charge in the 3.5 Inch Rocket Heads may account for the better performance of 75/25 Cyclotol in the M324 Shell. Significantly different performance between M324 Shell containing Composition B and M324 Shell containing 75/25 Cyclotol when these shell are fired from a gun against armor would not be expected because of the degrading effect of rotation on plate-penetrating ability.

20. It is noteworthy that in the tests in which 2.36 Inch Rocket Heads were the test medium the variability in results was so great that no definite conclusion regarding the relative effectiveness in this head of the four explosives tested seems warranted. On the basis of the averages of the penetration values for each explosive it appears that 70/30 Cyclotol is slightly superior to 50/50 Pentolite, which outperformed Composition B, which in turn appears equal to or better than 75/25 Cyclotol, depending on which group of tests is considered. The high viscosity of the molten 75/25 Cyclotol is believed to be a factor in the poor performance of this explosive in this series of tests as the explosive was too viscous to flow properly into the narrow region around the base of the conical liner. It has been shown in other studies that cavities in the explosive charge in this region may be responsible for erratic performance.

21. While 70/30 Cyclotol and 75/25 Cyclotol appear to offer little advantage in increasing the penetration ability of HEAT ammunition both explosives show promise for use in fragmentation items where a large number

*Lot HOL-5-16 (1951)

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of fragments and high fragment velocity are desired. High number of fragments and high fragment velocity are usually concomitant with high detonation velocity which is characteristic of these explosives. It is noted that in the tests of the 105 mm M1 HE Shell, 75/25 Cyclotol produced a smaller number of fragments than did 70/30 Cyclotol. This discrepancy may have been due to failure to recover some of the fragments from 75/25 Cyclotol filled shell because they were so small they passed through the No. 4* sieve used to separate fragments from the sand. In any case both of these explosives were definitely superior to Composition B with respect to fragmentation efficiency. They must be considered, therefore, as possible replacements for Composition B in fragmentation items.

22. It is noted that while 75/25 Cyclotol was indicated by the falling weight tests to be slightly more sensitive than the other two explosives, all three explosives appear to be essentially equivalent with respect to sensitivity to rifle bullet impact. It should be noted, also, that in safety and functioning tests conducted at Jefferson Proving Ground with 105 mm M1 HE Shell loaded with 75/25 Cyclotol (JPG Firing Record No. 144531, copy inclosed) all rounds fired without mishap and functioned properly.

23. It is believed that the 75/25 Cyclotol will be somewhat more difficult to load in production than Composition B to meet present cavity requirements. 70/30 Cyclotol, however, should present no greater difficulties than are now experienced with Composition B.

24. While there was no reason to believe that the thermal stability of either 75/25 Cyclotol or 70/30 Cyclotol would be unsatisfactory, it is of interest that the results of the 100°C and 120°C Vacuum Stability Tests indicate that both explosives are of excellent stability, being comparable with TNT and Composition B in this respect.

EXPERIMENTAL PROCEDURE

25. Loading of 3.5 Inch M28A2 Rocket Heads

a. 75/25 Cyclotol. Each rocket head was heated to approximately 70°C. The 75/25 Cyclotol was melted in a steam-heated melt kettle, heated to 87° - 89°C, and maintained with agitation at that temperature. The rocket head was assembled with a combination riser and thread protector (Pc Mk DP-64699-B1) which had been heated to approximately 70°C. The molten explosive was then poured slowly into the rocket head and riser until the latter was almost filled. When the explosive charge had solidified, the riser was removed and the surface of the explosive charge faced off to a depth of 0.520 / .015 inch as required by Dwg 82-16-36 rev 5-18-49.

* No. 4 sieve was used in accordance with standard procedure, since these fragmentation tests were performed prior to information that smaller than 4-mesh fragments are significant in fragmentation.

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b. 70/30 Cyclotol. The 70/30 Cyclotol was prepared by adding TNT to 75/25 Cyclotol. The TNT was first melted and then the 75/25 Cyclotol was added. The molten explosive was heated to 86° - 87°C and maintained at this temperature with agitation. Each rocket head was loaded as for 75/25 Cyclotol except that the rocket head was only warmed to approximately 35°C and the explosive was poured at 86° - 87°C.

c. Composition B. The Composition B was melted, heated to 85° - 86°C and maintained at that temperature with agitation. Each rocket head was loaded as for 75/25 Cyclotol except that the rocket head was only warmed to approximately 35°C and the explosive poured at 85° - 86°C.

d. 50/50 Pentolite. The 50/50 Pentolite was melted, heated to 87°C and maintained at that temperature with agitation. Each rocket head was warmed to approximately 35°C. The molten pentolite, at 87°C, was poured into the head to just above the apex of the cone. The explosive was allowed to cool to a mushy consistency; any crust on the surface of the charge was broken down during the cooling. A second pour of pentolite (at 83°C) was made to approximately 2 inches below the base end of the head. The explosive was allowed to cool as before with frequent break down of crusts formed on the surface of the charge. A third pour was made to approximately 1 inch below the base end. After approximately 1 minute the combination thread protector and riser was assembled to the head and pentolite (at 87°C) poured into the head and riser until the latter was almost filled. The explosive was allowed to solidify. The riser was removed and the surface of the explosive faced off as for the heads loaded with the other explosives.

26. Loading of 2.36 Inch T59E3 Rocket Heads:

a. 75/25 Cyclotol. Each rocket head was heated to approximately 70°C. The 75/25 Cyclotol was melted, heated to 87° - 89°C, and maintained at that temperature with agitation. The molten explosive was poured into the head to a distance of approximately 1/4" from the base of the head. Immediately a ring (SK 10163A) was set over the base of the head and a cardboard riser (6 inches long, 2 inches outside diameter and 1/10 inch wall thickness) set on top of the ring. Molten explosive was then poured into the head and riser until the latter was approximately 3/4 full. The explosive was allowed to solidify and the riser and ring then removed. The excess explosive at the base of the charge was removed by use of a steam-heated iron until the surface of the explosive was flush with the end of the rocket head. The booster cavity was then drilled as prescribed on Dwg TR 171 rev 4/17/47.

b. 70/30 Cyclotol. The cyclotol was prepared as described in Paragraph 25b. The rocket head was loaded as described for 75/25 Cyclotol except that the rocket head was only warmed to approximately 35°C and the explosive poured at 86° - 87°C.

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c. Composition B. The rocket head was loaded with Composition B as described for 75/25 Cyclotol except that the rocket head was only warmed to approximately 35°C and the explosive poured at 85° - 86°C.

d. 50/50 Pentolite. The rocket head was loaded with 50/50 Pentolite as described for 75/25 Cyclotol except that the rocket head was only warmed to approximately 35°C and the explosive poured at 83°C.

27. Loading of 105 mm M324 (T43) HEAT Shell:

a. 75/25 Cyclotol. 75/25 Cyclotol at a temperature of 87° - 89°C was poured into the shell to a distance of approximately 5" from the base end. The explosive was allowed to cool to a mushy consistency; any crust formed on the surface of the charge was broken down during the cooling. A second pour was made to a distance of about 1-1/2" from the threads at the base of the shell. The explosive was again allowed to cool to a mushy consistency with frequent breakdown of the crust formed on the surface of the charge. A riser (Pc Mk SK 14539) was then inserted at the base end of the shell and 75/25 Cyclotol (at a temperature of 87° - 89°C) was poured into the shell and riser until the latter was almost filled. When the explosive had solidified, the riser was removed and the booster cavity drilled in accordance with Dwg P-74537, rev 8/31/45.

b. 70/30 Cyclotol. The 70/30 Cyclotol was prepared as described in Paragraph 25b. The shell were loaded in the same manner as 75/25 Cyclotol except that the explosive was poured at approximately 86°C.

c. Composition B. The shell were loaded in the same manner as described for 75/25 Cyclotol except that the explosive was poured at approximately 85°C.

28. Loading of 90 mm M71 HE Shell:

a. 75/25 Cyclotol. A ring (SK-5213) and a riser (Pc Mk SO 1153D) were set in the nose end of the shell. The 75/25 Cyclotol, heated to 87 - 89°C, was poured into the shell and riser until the latter was almost filled. When the explosive had cooled, the riser was removed and the booster cavity drilled in accordance with Dwg 75-14-305 rev 8/15/45.

b. 70/30 Cyclotol. The Cyclotol was prepared as described in paragraph 25b. The shell were loaded as described for 75/25 Cyclotol except that the explosive was poured at approximately 86°C.

29. Loading of 105 mm M1 HE Shell:

a. 75/25 Cyclotol. The 75/25 Cyclotol, at a temperature of approximately 88°C was poured into the shell to a distance of approximately 3 to 4 inches from the nose of the shell. The explosive was allowed to cool to a mushy consistency; any crust formed on the surface of the charge was broken down during the cooling. A ring (SK-5213) and riser (Pc Mk SO 1153D)

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were set in the nose of the shell and 75/25 Cyclotol poured into the shell and riser until the latter was almost filled. When the explosive had solidified, the riser was removed and the booster cavity drilled in accordance with Dwg 75-14-206, rev 4/11/49.

b. 70/30 Cyclotol. The 70/30 Cyclotol was prepared as described in Paragraph 25b. The shell were loaded in the same manner as for 75/25 Cyclotol except that the explosive was poured at 86°C.

c. Composition B. The shell were loaded in the same manner as for 75/25 Cyclotol except that the explosive was poured at 85°C.

30. Loading of Rate of Detonation Sticks:

a. 75/25 Cyclotol. A paper tube (approximately 20" long x 1" OD x 0.8 to 0.9 Inch ID) was inserted into a cylindrical brass mold with a 1" ID. The 75/25 Cyclotol was melted, heated to 87° - 89°C and maintained at that temperature with agitation. The molten explosive was poured into the tube in the mold to a distance about 2" below the top. A funnel (Pc Mk BP-33555) was inserted in the top of the mold and the pouring of the explosive was continued until the funnel was 3/4 full. The explosive was allowed to solidify and the riser was then removed. The excess explosive was removed from the charge and the end surface was smoothed off with a steam heated iron until the surface of the explosive was flush with the end surface of the tube.

b. 70/30 Cyclotol. The Cyclotol was prepared as described in Paragraph 25b. The rate of detonation stick was loaded as described for 75/25 Cyclotol (Paragraph 30a) except that the explosive was poured at 86°C.

c. Composition B. The stick was loaded as described for 75/25 Cyclotol except that the explosive was poured at 85 - 86°C.

Note: The above explosive sticks were prepared for rate of detonation tests with the Potter Chronograph. For rate determinations by the drum camera method, the explosive sticks were prepared as described above except that the explosive was cast directly in the mold, thus eliminating the use of a confining paper tube.

31. Loading of Cups for Large Impact Test.

a. 75/25 Cyclotol. A funnel (80 1153D) was assembled to each impact test cup (Drawing PX-7-616, rev 9/22/49). The 75/25 Cyclotol was melted, heated to 87° - 89°C and maintained at that temperature with agitation. The molten explosive was poured into the cup and funnel until the latter was approximately 1/4 full. The explosive was allowed to solidify and the riser was then removed. The excess explosive was smoothed off with a steam-heated iron until the surface of the explosive was flush with that of the cup.

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b. 70/30 Cyclotol. The cyclotol was prepared as described in Paragraph 25b. The impact test cup was loaded as described in Paragraph 31a except that the explosive was poured at 86°C.

c. Composition B. The cup was loaded as described for 75/25 Cyclotol except that the explosive was poured at 85 - 86°C.

32. Loading of Rifle Bullet Impact Sensitivity Bombs

a. 75/25 Cyclotol. The 75/25 Cyclotol was melted, heated to 87° - 89°C and maintained at that temperature with agitation. The standard bomb (standard pipe nipple 2" diameter x 3" long with standard caps) was disassembled and the nipple was placed on a flat brass surface. Two rings (SK 5213 and SK 21957A) were affixed to the top surface of the nipple and the explosive was poured into the nipple and rings until the top ring was nearly full. The explosive was allowed to solidify and the rings were removed. The excess explosive was smoothed off with a steam-heated iron until the surface of the explosive was flush with that of the top surface of the nipple. The threads were wiped clean of explosive and the caps were threaded on the nipples. Each modified bomb (Dwg PX-7-638, dated 5/16/50) had a welded steel cover plate and a removable steel bolted plate. The bolted plate was removed and the bomb was loaded in the same way as the standard bomb.

b. 70/30 Cyclotol. The cyclotol was prepared as described in Paragraph 25b. The standard and modified bombs were loaded as described in Paragraph 32a except that the explosive was poured at 86°C.

c. Composition B. The standard and modified bombs were loaded as described for 75/25 Cyclotol except that the explosive was poured at 85 - 86°C.

33. Static Penetration Tests of 3.5 Inch M28 Rocket Heads:

Each head was set over a stack of 17 mild steel plates (top 5 plates were 5" x 5" x 1" and bottom 12 plates were 4" x 4" x 1" so that the nose of the ogive rested on the top plate. The head was supported by means of a cardboard tube and the total standoff distance was 4.2 inches. A standard booster (booster cup Pc Mk 73-10-38 F8, rev 3/7/50) and a pressed tetryl pellet, (0.63 inch in diameter, 0.63 inch in length and weighing 4.88 grams) was used to initiate these heads. A hole 9/32 inch in diameter was drilled in the detonator holder (Pc Mk 73-10-38E9, rev 3/7/50) to take a du Pcnt No. 6 Electric Blasting Cap. The charge was fired and the penetration measured to the nearest 0.1 inch.

34. Static Penetration Tests of 2.36 Inch T59E3 Rocket Heads:

Each head was set over a stack of 14 mild steel plates (each, 4" x 4" x 1") using a cardboard tube to give a total standoff distance of 4.8 inches. A pressed tetryl booster pellet (0.92 inch in diameter x 0.62 inch

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long and weighing 10.9 grams) was inserted in the booster cavity and a du Pont No. 6 Electric Blasting Cap centered over the booster pellet by means of a wooden detonator holder. The charge was fired and the penetration was measured to the nearest 0.1 inch.

35. Static Penetration Tests of 105 mm (T43) HEAT Shell:

Each shell was placed over a stack of 25 mild steel plates (top 6 plates were 6" x 6" x 1" and bottom 19 plates were 5" x 5" x 1"). The ogives were cut off so that the total standoff distance was 6.5 inches. A pressed tetryl pellet (1.39 inches diam x 0.51 inch length, having a minimum density of 1.55 gm/cc) was inserted in the booster cavity. A Type II U. S. Army Special Blasting Cap was then centered over the booster pellet by means of a special wooden detonator holder. The charge was fired and the penetration measured to the nearest 0.1 inch.

36. Fragmentation Tests of 90 mm M71 HE Shell and 105 mm M1 HE Shell.

Each shell was fragmented in sand in accordance with procedure outlined in Picatinny Arsenal Testing Manual No. 5-1 dated 24 August 1950, "Fragmentation Testing Procedures".

37. Vacuum Stability Tests.

Tests were made at 100°C and 120°C in accordance with procedures described in Reference E.

38. Rate of Detonation Tests:

a. Potter Counter Chronograph Method - Ionization pickups, in the form of twisted insulated wires, with ends cut off, were taped to each end of the charge (.8 to .9" diameter x 20" length) and connected through a battery circuit to a Potter Counter Chronograph which was used to measure the detonation time. Each charge was boosted by three tetryl pellets 2 of which were solid and the third contained a central hole to accept a Type II U. S. Army Special Blasting Cap (used as the initiator). The pellets were 1 inch in diameter, 3/4 inch high and had a density of 1.59 gm/cc. Each charge was taped to a wooden board and secured by a heavy weight.

b. Drum Camera Method - Each charge (1 inch diameter x 20 inches length) was wrapped in one or two thicknesses (0.003 inch thickness per wrap) of cellulose acetate film. The charges were suspended in the firing chamber and were initiated by 2 pressed tetryl pellets (1 inch diameter x 1/2 inch high, one solid and one drilled) and a Type II U. S. Army Special Blasting Cap. The rotating camera recorded the flashes and the rates were determined from the film.

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39. Viscosity Determinations - Efflux viscosities were determined in accordance with the method described in Specification JAN-C-401 (Composition B) except that the samples were melted in a steam bath instead of in the melt pot prescribed.

40. Rifle Bullet Impact Sensitivity Test - Standard bombs (standard pipe nipple 2 inches diameter x 3 inches length with standard caps, loaded with explosive) and modified flat-target faced bombs (Dwg PX-7-638 dated 5/16/50) were tested. Standard bombs were placed with axis of cylinder perpendicular to ground, while the modified bombs were placed with axis of cylinder parallel to the ground and the target face perpendicular to the line of fire. Cal.30 M2 Ball Bullets with a muzzle velocity of 2740 ft/sec were fired at the respective bomb targets at a distance of 90 feet. Ten trials constituted one test. The targets were observed for action (low order detonation, high order detonation, smoke, burning or no action) of the explosive charge.

41. Impact Sensitivity Tests - Tests were performed on the respective explosives (Composition B, 70/30 Cyclotol and 75/25 Cyclotol) using the Bureau of Mines Large Scale Impact Machine and special holders designed at this Arsenal. The sensitivity as determined by these tests is the height of fall of the 100-kilogram weight for which at least one action (smoke, fire or noise) occurs in 10 trials but for which no actions occur (in 10 consecutive trials) at a height of fall 1/2 foot lower than the height at which the action occurred. The test metal parts used were as shown in Dwg PX-7-616 dated 9/22/49.

REFERENCES

- A. Holston Defense Corporation Report No. 20-T-7 dated 6 November 1950. "The Pilot-Plant Production of Low Apparent Viscosity 75/25 Cyclotol"
- B. 2d Indorsement dated 4 October 1950 on letter from the Office of the Chief of Ordnance to Picatinny Arsenal, subject: Experimental Loading 3.5 Inch Rocket Heads, OO 471.94/411 Rocket (c), ORDBB 471.86/2083-49.
- C. Letter from the Office of the Chief of Ordnance to Picatinny Arsenal dated 20 July 1951, subject: Composition B Loading of Artillery Shell (Project TAL-3501), OO 471.14/128, ORDBB 471.86/15-7.
- D. Picatinny Arsenal Technical Report No. 1688 entitled "Evaluation of Explosives Based on Shell Fragmentation."
- E. Picatinny Arsenal Technical Report No. 1401 (Rev 1) "Standard Procedures for Laboratory Testing of Explosives."

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INCLOSURES

Tables I - IV

Firing Test Record Nos. 3870, 4043A, 4043B, 4043C, 4043D

Chemical Laboratory Report No. 137460

Jefferson Proving Ground Firing Record No. 144531

Photographs M-39456, M-39458, M-39454, M-31219, M-38968, M-38643

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TABLE I

INITIAL VALUES FOR DENSITY OF EXPLOSIVE CHARGE AND DEPTH OF PENETRATION INTO MILD STEEL TARGETS AT 4.2 INCHES STANDARD DISTANCE FOR 3.5 LBS/H, 10242, RECENT BANDS

Loaded With 7½/25 Cylolat, 70/30 Cylolat, Composition B and 50/50 Penolite

Group of Tests	1	2	3	4	5	6	7	8
Head Metal Parts Lot H-2-2-2 Loaded With 70/30 Cylolat, Lot	Head Metal Parts Lot H-2-1-42. Loaded With 70/30 Cylolat, Lot	Head Metal Parts Lot H-2-2-2 Loaded With Composition B Cylolat, Lot	Head Metal Parts Lot H-2-1-76. Loaded With 70/30 Cylolat, Lot					
Composition B Lot H-2-2-2 Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.	Depth of Penetration -Inches.
14.1	13.7	14.7	14.7	14.5	14.2	14.2	14.8	14.8
14.4	14.7	14.7	14.2	14.7	14.7	14.7	14.6	14.9
14.4	14.7	14.7	14.2	14.7	14.7	14.7	14.6	14.9
14.4	14.0	14.9	14.5	14.7	14.1	14.1	14.1	14.9
14.2	14.7	14.8	14.7	14.8	14.1	14.1	14.5	14.5
14.7	15.0	14.8	14.3	14.9	14.9	14.0	14.1	14.7
14.4	14.6	14.9	14.1	14.7	14.7	14.2	14.1	14.6
13.7	14.3	14.2	14.0	14.6	14.6	14.4	14.7	13.0
14.8	14.5	14.5	14.2	14.6	14.6	14.3	14.6	14.0
13.1	14.4	14.6	14.6	14.5	14.0	14.6	14.6	13.8
13.7	13.2	14.6	14.1	14.7	14.8	14.1	14.7	14.6
14.7	14.7	14.8	14.2	14.7	14.7	14.2	14.7	14.6
13.8	14.0	14.5	13.5	14.5	14.5	14.1	14.6	13.6
Average	14.19	14.30	14.69	14.66	14.56	14.73	14.39	14.42

^a 4-second nodinal viscosity.

^b Made by starting 7½/25 Cylolat, Lot H-2-2-2 with TMR, Lot PFM 5559.

^c Lot number unknown. This group of bands was loaded at Holston Ordnance Works, but tested at Picatinny Arsenal.

^d 5-second nodinal viscosity

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TABLE II

Individual Values of Depth of Penetration into Mild Steel Targets
at 4.8 Inches Standoff Distance of 2.36 Inch T59E3 Rocket Heads^a
Loaded with 75/25 Cyclotol, 70/30 Cyclotol, Composition B and
50/50 Pentolite

Group of Tests	1	2	3	4	5	6
Explosive in Head	Composition B	75/25 Cyclotol	75/25 Cyclotol	70/30 Cyclotol	70/30 Cyclotol	50/50 Pentolite
(Lot No.)	(HOL-3-6)	(HOL-E-5-1)	(HOL-E-5-1)	(See Footnote) ^b	(See Footnote) ^b	(RAD-1171)
Depth Inches	Depth Inches	Depth Inches	Depth Inches	Depth Inches	Depth Inches	Depth Inches
10.0	9.8	10.4	9.7	11.8	9.1	
11.3	11.5	11.4	8.1	11.4	11.9	
10.2	9.2	6.8	10.5	12.7	11.9	
11.0	6.5	6.7	9.3	12.7	10.7	
10.9	9.9	11.3	10.0	11.4	12.1	
9.3	6.4	13.2	10.0	10.6	9.7	
12.0	7.2	8.7	8.6	10.8	11.1	
9.9	7.0	10.5	10.6	11.1	6.5	
9.9	9.6	11.4	11.1	11.9	11.4	
9.8	7.0	10.4	11.5	9.0	8.8	
10.4	8.1	8.0				
9.7	8.4	9.0				
8.4	7.7	8.8				
7.8	11.1	11.9				
9.8	6.9	9.1				
Average	10.05	8.42	10.08	9.75	11.34	10.32

^a - Head Metal Parts Lot BWL-1 with paint removed from both sides of cone
^b - 70/30 Cyclotol made by diluting 75/25 Cyclotol of Lot HOL-E-5-1 with TNT

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TABLE III

Individual Values of Depth of Penetration into Mild Steel Targets
at 6.5 Inches Standoff Distance by 105 mm M324 (T43) HEAT Shell^a
Loaded with Composition B, 70/30 Cyclotol and 75/25 Cyclotol

Explosive in Head (Lot No.)	Composition B (HOL-3-6) ^b	70/30 Cyclotol ^c (See Footnote)	75/25 Cyclotol (HOL-E-5-1)
	Depth Inches	Depth Inches	Depth Inches
	21.0	22.3	23.1
	21.8	23.5	22.6
	22.2	21.1	23.3
	21.8	21.2	
	22.3	21.8	
	23.0	23.1	
	23.1	22.1	
	22.6	22.1	
	22.8	21.9	
	21.2	21.9	
		21.9	
Average	22.18	22.04	23.0

^a - Cones in these shell were of the same design as the steel cone shown on Dwg 75-4-107L3 except that they were made of copper.

^b - 5 second nominal viscosity

^c - Made by diluting 75/25 Cyclotol (Lot HOL-E-5-1) with TNT (Grade I)

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TABLE IV

Rates of Detonation of 75/25 Cyclotol, 70/30 Cyclotol and Composition B
as Determined by Potter Chronograph and Drum Camera Methods

<u>Method</u>	<u>Rate of Detonation - Meters/second</u>								
	<u>Composition B</u>			<u>70/30 Cyclotol</u>			<u>75/25 Cyclotol</u>		
	<u>Rate</u>	<u>Density</u> <u>gm/cc</u>	<u>Stick</u> <u>Inches</u>	<u>Rate</u>	<u>Density</u> <u>gm/cc</u>	<u>Stick</u> <u>Inches</u>	<u>Rate</u>	<u>Density</u> <u>gm/cc</u>	<u>Stick</u> <u>Inches</u>
Potter Chrono- graph	7800	1.67 ^a	0.9 ^b	7984	1.70 ^a	0.9 ^b	8031	1.70 ^a	0.8 ^b
	7769	"	"	7922	"	"	8047	"	"
	7740	"	"	7831	"	"	8031	"	"
				7937	"	"	8031	"	"
Average	7770	1.67	0.9	7919	1.70	0.9	8035	1.70	0.8
Drum Camera	7825	1.69 ^a	1.0 ^c	7895	1.69 ^a	1.0 ^b	7954	1.71 ^a	1.0 ^c
	7850	"	"	7900	"	"	7900	"	"
	7796	"	"	7884	"	"	7960	"	"
Average	7827	1.69	1.0	7893	1.69	1.0	7938	1.71	1.0

^a - Density was determined for a representative stick by water displacement method

^b - These explosive sticks were cast in cylindrical cardboard tubes (wall thickness aprx .08") and fired this way

^c - These sticks were not confined by cardboard tubing

shell: $\infty = M_2 \cdot \pi_2 \cdot \pi_3 \cdot \pi_4$

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DELL, M.L., DAB, J.: 1942

Page: (3/25 Cycle 5), Lot: 3002

Method of functioning. *M.4 FUSE*

Size of Box 10" x 10" x 20"

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4 MESSI

FRAGMENTED IN SARC

PICATINNY ARSENAL FRAGMENTATION TEST THICK PINE

RESULTS

TEST RECORD NO. 3870
DATE MARCH 19-24, 1951

Projectile: 90 mm, HE, M71

Fuze: M54, Modified, DWG PX-97-287A

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Charge: 70/30 Cyclotol

Fragmented in Sand Bldg 607; No 4 Mesh

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Size of Box: 10" x 10" x 20" $\frac{1}{2}$ " Pine

Fragmented; June 1951

Fragmented at Amb. Temperature

PICATINNY ARSENAL FRAGMENTATION TEST

RESULTS

TEST RECORD NO. 4043A

DATE June 1951

Shell No.	Wt. Empty Lbs.	Wt. Loaded Lbs.	Number and Weight of Recovered Fragments										Sp. Gr. of Charge			
			No. 0 Group 0 to 75 Grs.		No. 1 Group 75 to 150 Grs.		No. 2 Group 150 to 750 Grs.		No. 3 Group 750 to 2500 Grs.		No. 4 Group 2500 Grs. over					
			No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.				
31	19.10	21.34	951	3.14	149	2.29	221	9.97	16	2.19	1	.84	1338	18.43	95.5	38968
32	19.06	21.32	916	2.73	160	2.42	214	9.63	25	3.74	-	-	1315	18.52	97.2	
33	19.19	21.42	887	3.09	156	2.36	216	9.86	20	2.46	1	.79	1280	18.56	96.7	
35	19.00	21.25	1022	3.43	172	2.54	238	10.65	11	1.73	-	-	1443	18.35	96.6	
36	19.07	21.33	969	3.06	174	2.60	228	9.61	19	3.19	-	-	1390	18.46	96.8	
36	19.05	21.30	989	3.13	148	2.28	225	9.47	22	2.75	1	.82	1385	18.45	96.9	
37	19.09	21.34	1075	3.36	160	2.34	200	9.26	22	3.40	-	-	1457	18.36	96.2	
38	19.05	21.32	932	3.13	145	2.19	221	9.61	21	3.52	-	-	1319	18.45	96.9	
39	19.12	21.36	886	2.96	170	2.60	214	9.71	21	3.16	-	-	1291	18.43	96.4	
40	19.04	21.30	966	2.97	140	2.12	232	10.47	18	2.91	-	-	1356	18.47	97.0	4-38969
41	19.08	21.33	959	3.10	157	2.37	221	9.82	20	2.91	-	-	1357	18.45	96.7	
Prepared by:			Reviewed by:										Approved by:			
Martin B. Chase Ordnance Engineer			L. Page Ordnance Engineer										J. H. McIvor Proof Director			
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Shell 105 mm, M1, HE, lot 1M1-2-1

Charge 75/25 C3, 1000

Fuze M54 Mod. 348 37-289

Size of Box, 20 x 20 x 20

Fragmented in Series Box 20 x 20 x 20 Mesh

Fragmented at 4000 ft. 1000 ft. height

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PICATINNY ARSENAL FRAGMENTATION TEST

RESULTS

TEST RECORD NO. 4043 B

DATE AUGUST 1951

Shell No.	Wt. Empty Lbs.	Wt. Loaded Lbs.	Number and Weight of Recovered Fragments												Sp. Gr. of Charge
			No. 0 Group 0 to 75 Grs.	No. 1 Group 75 to 150 Grs.	No. 2 Group 150 to 750 Grs.	No. 3 Group 750 to 2500 Grs.	No. 4 Group 2500 Grs., over	Total			Percent of Fragments Recovered			Photo No.	
No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	Photo No.	Sp. Gr. of Charge
1	25.00	31.00	1	1.00	1	0.35	1	0.35	1	0.35	1	2169	24.62	94.7	4-39455
2	25.00	31.00	1	1.00	1	0.35	1	0.35	1	0.35	1	2351	24.98	95.9	4-39455
3	25.96	31.17	1034	3.38	257	3.72	288	11.99	25	4.02	1	2261	25.11	96.4	
4	25.38	32.35	1034	5.54	242	3.66	258	10.58	32	5.06	1	2423	24.84	95.3	
5	25.75	31.11	1713	6.66	335	3.61	288	11.90	23	3.49	1	2361	24.66	95.8	
6	25.90	32.15	1368	3.78	292	4.27	269	11.48	23	3.32	1	2452	24.85	95.9	
7	25.90	31.39	1712	5.18	269	4.00	276	11.94	25	3.86	1	2285	24.98	96.4	4-39454
8	26.00	31.09	1636	5.49	274	3.99	272	11.62	25	4.04	1	2205	25.14	96.7	
9	26.01	31.14	1672	5.62	247	3.79	272	12.40	20	3.38	1	2211	24.89	95.7	
10	25.88	32.00	2010	6.36	285	4.18	283	13.83	17	2.37	1	2595	24.74	95.6	
11	25.95	31.08	1760	5.71	277	3.89	277	12.70	24	3.67	1	2331	24.88	95.84	

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Shell: 105 mm, M1, HE, lot LMG-2-1

Charge: T0/30 Cyclotol

Fuze: M54 Mod, Dwg 97-287

Size of Box: 10" x 10" x 20" - 1/2" pine

Fragmented in Sand; Bldg 607, No. 4

^{4th} PICATINNY ARSENAL

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PICATINNY ARSENAL FRAGMENTATION TEST

Fragmented at Ambient Temperature

RESULTS TEST RECORD NO. 4043 C

DATE August 1951

Shell No.	Wt. Empty Lbs.	Wt. Loaded Lbs.	Number and Weight of Recovered Fragments												Sp. Gr. of Charge	
			No. 0 Group 0 to 75 Grm.		No. 1 Group 75 to 150 Grm.		No. 2 Group 150 to 750 Grm.		No. 3 Group 750 - 2500 Grm.		No. 4 Group 2500 Grm. over		Total	Percent of Fragments Recovered	Photo No.	
No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.			
11	26.08	31.21	1950	5.82	277	4.30	256	10.94	27	4.10	-	-	2510	25.16	96.5	
12	26.06	31.20	1974	5.72	250	3.74	259	12.07	18	2.74	2	0.89	2503	25.16	96.5	
13	26.07	31.22	1886	5.42	328	4.62	357	11.72	24	3.38	-	-	2595	25.14	96.4	
14	25.91	31.02	1747	5.50	232	3.49	292	13.00	19	2.43	1	0.42	2291	24.84	95.9	
15	26.02	31.15	2029	6.34	280	4.32	262	11.19	22	2.95	-	-	2593	24.80	95.3	
16	25.95	31.10	1910	5.80	278	4.30	256	10.84	26	4.02	-	-	2470	24.96	96.2	M-39456
17	26.00	31.12	1802	5.72	268	3.95	267	11.14	23	3.74	1	0.46	2361	25.01	96.2	
18	26.01	31.12	1897	5.54	241	3.53	278	11.62	29	4.40	-	-	2445	25.09	96.5	
19	25.92	31.06	1843	5.58	311	4.65	262	10.59	23	3.68	1	0.40	2440	24.90	96.1	
20	26.03	31.14	1881	5.60	271	4.11	265	10.95	29	4.37	-	-	2446	25.03	96.2	
Avg	26.00	31.13	1892	5.70	274	4.10	275	11.40	24	3.58	1	.22	2465	25.00	96.18	

CONFIDENTIAL
SECURITY INFORMATION

Shell: 105 mm, M1, HE, Lot LMG-2-1

Charge: Comp B

Fuze: M54 Mod, Dwg 97-287

Size of Box: 10" x 10" x 20" - 1/2" pine

Fragmented in Sand, Bldg 607, No. 4 Mesh

PICATINNY ARSENAL FRAGMENTATION TEST

CONFIDENTIAL
SECURITY INFORMATION

Fragmented August 1951

Fragmented at Ambient Temperature

RESULTS TEST RECORD NO. 4043 D

DATE August 1951

Shell No.	Wt. Empty Lbs.	Wt. Loaded Lbs.	Number and Weight of Recovered Fragments												
			No. 0 Group 0 to 75 Grn.		No. 1 Group 75 to 150 Grn.		No. 2 Group 150 to 750 Grn.		No. 3 Group 750 - 2500 Grn.		No. 4 Group 2500 Grn. over		Total	Percent of Fragments Recovered	Sp. Gr. of Charge
No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.	No.	Wt. Lbs.
21	26.03	31.08	1593	4.82	239	3.81	278	12.59	24	3.87	-	-	2134	25.09	96.4
22	25.71	30.80	1716	5.00	235	3.44	282	12.25	31	4.53	-	-	2264	25.22	98.1
23	25.89	30.95	1530	4.29	229	3.30	278	12.25	35	4.92	1	0.38	2073	25.14	97.1
24	25.93	30.98	1536	4.61	193	2.90	233	11.06	35	5.35	3	1.24	2000	25.16	97.0
25	26.03	31.07	1703	5.27	261	3.81	233	11.06	23	3.59	-	-	2280	24.85	95.5
26	25.94	30.99	1488	5.00	239	3.69	265	12.35	24	4.14	-	-	2016	25.18	97.1
27	25.89	30.97	1550	4.80	205	3.39	282	12.47	31	4.64	-	-	2068	25.30	97.7
28	26.00	31.03	1157	3.60	208	3.27	288	12.69	34	5.70	-	-	1687	25.26	97.2
29	26.10	31.12	1533	4.82	236	3.54	278	11.92	33	5.14	-	-	2080	25.42	97.4
30	26.14	31.18	1528	4.74	207	3.15	288	12.38	29	5.02	-	-	2052	25.29	96.7
Avg	25.96	31.02	1533	4.70	225	3.43	277	12.21	30	4.69	-	-	2065	25.19	97.02
Prepared by:	Martin B. Chase Ordnance Engineer				Reviewed by: L. P. Page								Approved by: J. H. Major		

CONFIDENTIAL
SECURITY INFORMATION

CONFIDENTIAL
 SECRET INFORMATION
PICATINNY ARSENAL DOVER, N.J.
 CHEMICAL
REPORT FROM THE GENERAL LABORATORY

REPORT NO.	
1401-60	DATE 29 June 1951

SAMPLE NO.

KIND OF SAMPLE	Cyclotol
RECEIVED FROM	Propellants and Explosives Engineering Branch
REFERENCE OR X. O.	
REPRESENTING	Batches of Cyclotol, as designated, submitted in connection with Project No. EPO-EP-14B

OBJECT:

To make the following test.

RESULTS:

Material	Test No.	100°C Vacuum Stability Test		120°C Vacuum Stability Test	
		ML Gas	Hours	ML Gas	Hours
75/25 Cyclotol*	1	0.23	40	0.41	40
"	2	0.36	40	0.70	40
70/30 Cyclotol	1	0.26	40	0.47	40
"	2	0.31	40	0.75	40

REMARKS:

The above tests were made in accordance with the procedures described in P. A. Technical Report No. 1401 (Rev 1).

*Lot HOL-E-5-1

WES-18

WORK BY: B. Kanouse, J. Wingler

SUBMITTED:
Head, Stability Sub-Section

APPROVED:
Chief, Gen Lab Section

CONFIDENTIAL
SECURITY INFORMATION

OBJECT OF FIRING:

JEFFERSON PROVING GROUND FIRINGS

Special Test of Shell, Semi-Fixed, H.E.
(Comp. A, M1, Dualgrain, w/Fuze, M73,
Dummy), (Comp. B, M1, Dualgrain, w/Fuze,
M51A5, Inert), (75/25 Cyclotol, M1,
Dualgrain, w/Fuze, M51A5, Inert),
(Comp. B, M1, Dualgrain, w/Fuze, I.D.,
M51A5), (75/25 Cyclotol; M1, Dualgrain,
w/Fuze I.D., M51A5) for 105mm Howitzers

lfr: Picatinny Arsenal

Lots: PA-E-7145, -6845, -6847, -6846, and 6848.

LOTS PA-E-7145, -6845, -6847,
-6846 and -6848

DATE OF FIRING 27 Sept. 1951

FIRING RECORD NO. 144531

SHEET 1 OF 12

SAMPLES REC'D 21 Sept. 1951

PURPOSE OF TEST

The purpose of this test was to develope an improved bursting charge for the 105mm M1 Shell, to determine whether this type ammunition can be fired safely and will function properly.

AUTHORITY

This test was authorized by letter ORDTR-T File No. 471.86/15-10 and ORDTR FILE No. 471.1/227 received this station 22 September 1951 and fired in accordance with Test Request Nos. 3252 and 3268, Picatinny Arsenal, dated 15 September 1951 and telephone conversation between Mr. H. C. Foerstner, Jefferson Proving Ground and Mr. Tweed, Picatinny Arsenal, 26 September 1951.

TEST PROCEDURE

Fifty (50) samples, Lot PA-E-6845, Fifty (50) samples, Lot PA-E-6847, and two hundred (200) samples, Lot PA-E-7145 were fired using propelling charge adjusted to give a pressure of approximately 36,400 P.S.I., using FFH Powder, M1, Lot 3AJ-15486. These rounds were conditioned at 70°F for twenty-four (24) hours and fired without appreciable change in temperature. Range and pressure was recorded on each round. Fifteen (15) samples, Lot PA-E-6845 and fifteen (15) samples, Lot PA-E-6847 were conditioned at +160°F for twenty-four (24) hours and fired alternately without appreciable change in temperature. Pressure and range was recorded on each round. Ten (10) samples, Lot PA-E-6846 and ten (10) samples Lot PA-E-6848 were conditioned at 70°F for twenty-four (24) hours and fired alternately with ten (10) standard rounds without appreciable change in temperature. These rounds were fired to 2900 yard field for graze impact. Velocity, pressure, range and functioning was recorded on each round. Ten (10) samples, Lot PA-E-6846 and ten (10) samples, Lot PA-E-6848 were conditioned at -40°F for twenty-four (24) hours and fired alternately without appreciable change in temperature to 2900 yard field for graze impact. Velocity, range, pressure and functioning was recorded on each round. Ten (10) samples, Lot PA-E-6846 and ten (10) samples, Lot PA-E-6848 were conditioned at +125°F for twenty-four (24) hours and fired alternately without appreciable change in temperature to 2900 yard field for graze impact. Velocity, range, pressure and functioning was recorded on each round.

PROVING GROUND LIBRARY

APPROVED C. R. TEABOLDT
Lt Col, Ord Corps
Commanding

BY W. A. BRENNAN, JR.
Capt, Ord Corps
Assistant

W. A. Brennan ✓ *Malvred J. Custer*
MILDRED J. CUSTER
Proof Tech, Ord Corps
Proof Director

JEFFERSON PROVING GROUND FIRINGS

LOTS PA-E-7145, -6845, -6847,
 -6846, and -6848
 DATE OF FIRING 27 Sept. 1951
 FIRING RECORD NO 144531
 SECTION 2 OF 12

WEAPON INFORMATION

Fired from 105mm How.	M2A1	No. 13103	Mfr: Chain Belt Co., 1945
Tube 105mm How.	M2A1	No. 17966	Mfr: Long Beach Machine Works
Carriage 105mm	M2A2	No. 7799	Mfr: Pullman Standard, 1944
Recoil Mech. 105mm	M2A1	No. 11846	Mfr: Byron Jackson Co. 1944

SUMMARY

Lot No.	Temp. of Ammunition	Elev. Fils	Velocity			Pressure PSI/100			Range (Yds.)		
			No. of Rds. cons.	Max. Mean	Disp.	No. of Rds. cons.	Max. Mean	Disp.	No. of Rds. Cons.	Max. Mean	Disp.
PA-E-6845	70°F	390				*47	367	29	17	9718	59
6845	70°F	395							26	9777	75
6847	70°F	395				50	366	33	50	9805	183
7145	70°F	395				50	373	47	49	9353	259
7145	70°F	395				150	373	53	149	9909	275
6845	+150°F	415				15	382	18	13	9916	138
6847	+160°F	415				15	380	17	14	9899	154
Std. Rds.	70°F	75	8	1550	8	10	336	17	10	2978	61
PA-E-6846	70°F	75	10	1544	12	10	330	13	10	2937	57
6848	70°F	75	10	1543	10	10	330	6	10	2935	81
6846	-40°F	75	10	1509	12	10	262	30	10	2805	71
6848	-40°F	75	10	1505	14	10	265	18	10	2789	.69
6846	+125°F	75	10	1570	8	10	361	9	10	3066	69
6848	+125°F	75	10	1565	11	10	360	13	10	3048	65

* Three (3) rounds were fired to establish charge.

CONCLUSION

As a result of this test, both Comp. B and Cyclotol were found to be satisfactory bursting charges for the 105mm M1 Shell. All rounds in this test fired safely and functioned properly.

JEFFERSON PROVING GROUND FIRINGS

LOTS PA-E-7145, -6845, -6847,
-6846, -6848.

DATE OF FIRING 27 Sept. 1951

FIRING RECORD NO 144531

SHEET 3 OF 12

COMPONENTS

LOT PA-E-7145

Fuze: M73, Dummy, Lot EOP-7-15
 Cart. Case: M14, Lot CB & C-24
 Primer: M28B2, Lot KOP-7-309
 Projectile: H.E., M1, Lot LANSCO-479-970
 Powder: FNH, M1, Lot BAJ-15486
 Filler: Comp. B, Lot HOL-2-3

Standard Components

Fuze: M51A1 (inert) Mixed
 Cart. Case: M14, Resized, Mixed
 Primer: M28B2, Lot KOP-10-92
 Projectile: M1, ODP-321
 Powder: Lot ID-36172(SP) -17395(MP)

LOT PA-E-6845

Fuze: #M51A5, (Inert) Lot FA-Unknown
 Cart. Case: M14, Lot CB & C-24
 Primer: M28B2, Lot KCI-10-199
 Projectile: H.E., M1, Lot GAT-1-1
 Powder: Prop., Dualgrain, Lots PA-B-36602(MP), PA-B-36502(SP), 50 Rds. FNH, M1, Lot BAJ-15486.
 Filler: Comp. B, Lot HOL-2-9.

LOT PA-E-6847

Fuze: #M51A5, (Inert) Lot FA-Unknown
 Cart. Case: M14, Lot CB & C-24
 Primer: M28B2, Lot KCI-10-199
 Projectile: H.E., M1, Lot GAT-1-1
 Powder: Prop., Dualgrain, Lots PA-B-36602(MP), PA-B-36502(SP), 50 Rds. FNH, M1, Lot BAJ-15486.
 Filler: 75/25 Cyclotol, Lot HOL-E-5-1

LOT PA-E-6846

Fuze: I.D., .05 Sec. Delay, M51A5, Lot JA-502-74
 Cart. Case: M14, Lot CB & C-24
 Primer: M28B2, Lot KCI-10-199
 Projectile: H.E., M1, Lot GAT-1-1
 Powder: Prop., Dualgrain, Lots PA-B-36602(MP), PA-B-36502(SP)
 Filler: Comp. B, Lot HOL-2-9

LOT PA-E-6848

Fuze: I.D., .05 Sec. Delay, M51A5, Lot JA-502-74
 Cart. Case: M14, Lot CB & C-24
 Primer: M28B2, Lot KOP-10-199
 Projectile: H.E., M1, Lot GAT-1-1
 Powder: Prop., Dualgrain, Lots PA-B-36602(MP), PA-B-36502(SP)
 Filler: 75/25 Cyclotol, Lot HOL-E-5-1

* Renovated from M48 Fuse.

JEFFERSON PROVING GROUND FIRINGS

LOT PA-E-6845
 DATE OF FIRING 27 Sept. 1951
 FIRING RECORD NO. 144531
 SHEET 4 OF 12

(70°F - Excess Press. Phase)

Round No.	Mfr. No.	Time of Firing	Elev. Mils	Fuze Set.	Mean. Range Yds.	Press PSI 100	Powder Chg. lbs.	Powder Lot
<u>Condition: Morris 3123, 3124</u>								
3125	45	0806	330	(Inert)	**10000	380	48.00	BAJ-15486
3126	39	0807	"	"	10010	373	"	"
3127	65A	0808	"	"	10090	376	"	"
3128	53	0809	300	"	9602	372	47.75	"
3129	23	0810	"	"	9654	371	"	"
3130	13	0811	"	"	9657	371	"	"
3131	23	0812	390	"	9744	372	"	"
3132	52A	0813	"	"	9722	363	"	"
3133	1A	0814	"	"	9735	368	"	"
3134	26	0815	"	"	9703	359	"	"
3135	47B	0816	"	"	9685	369	"	"
3136	8	0817	"	"	9717	364	"	"
3137	57	0818	"	"	9722	376	"	"
3138	61	0819	"	"	9700	366	"	"
3139	4	0820	"	"	9740	372	"	"
3140	37A	0821	"	"	9703	372	"	"
3141	11	0822	"	"	9726	371	"	"
3142	51A	0823	"	"	9726	376	"	"
3143	21A	0824	"	"	9710	365	"	"
3144	16	0825	"	"	9717	368	"	"
3145	15A	0826	"	"	9714	365	"	"
3146	50	0827	"	"	9714	369	"	"
3147	17	0828	"	"	9726	376	"	"
3148	2	0829	395	"	9809	372	"	"
3149	20	0830	"	"	9790	371	"	"
3150	38	0831	"	"	9752	367	"	"
3151	42	0832	"	"	9787	366	"	"
3152	6	0833	"	"	9802	371	"	"
3153	14	0834	"	"	9763	369	"	"
3154	44	0835	"	"	9784	369	"	"
3155	34	0836	"	"	9752	363	"	"
3156	27B	0837	"	"	9778	366	"	"
3157	10	0838	"	"	9802	364	"	"
3158	41	0839	"	"	9783	364	"	"
3159	73	0840	"	"	9734	347	"	"
3160	30	0841	"	"	9791	368	"	"
3161	59A	0842	"	"	9749	362	"	"
3162	53A	0843	"	"	9794	367	"	"
3163	54A	0844	"	"	9793	368	"	"
3164	36	0845	"	"	9731	372	"	"
3165	5	0846	"	"	9773	364	"	"
3166	48	0847	"	"	9779	363	"	"
3167	33	0848	"	"	9775	366	"	"
3168	64A	0849	"	"	9762	359	"	"
3169	18	0850	"	"	9765	363	"	"
3170	60A	0851	"	"	9742	367	"	"
3171	43	0852	"	"	9793	368	"	"
3172	24B	0853	"	"	9778	372	"	"
3173	19	0854	"	"	9772	367	"	"
3174	3	0855	"	"	9755	373	"	"

** Estimated Range

EFFECW ON PROVING GROUND FIRINGS

LOT PA-2-6847
 DATE OF FIRING 27 Sept. 1961
 FIRING RECORD NO. 144531
 SHEET 6 OF 12

(70°F - Excess Press. Phase)

Round No.	Mfr. No.	Time of Firing	Elev. Mils	Fuze		Mens. Range Yds.	Press 100 PSI	Powder	
				Set.	Act.			Chg. Oss.	Lot
3175	1073	0856	395	Inert		9747	363	47.75	BAJ-15486
3176	1030	0856	"	"		9781	366	"	"
3177	1363	0857	"	"		9782	360	"	"
3178	1508	0857	"	"		9769	364	"	"
3179	119	0858	"	"		9795	363	"	"
3180	103C	0858	"	"		9760	367	"	"
3181	122A	0959	"	"		9737	370	"	"
3182	126	0859	"	"		9735	373	"	"
3183	106	0900	"	"		9796	372	"	"
3184	131B	0900	"	"		9772	371	"	"
3185	105A	0901	"	"		9813	375	"	"
3186	154A	0901	"	"		9762	362	"	"
3187	113B	0902	"	"		9773	368	"	"
3188	162B	0902	"	"		9772	369	"	"
3189	137A	0903	"	"		9791	366	"	"
3190	115B	0903	"	"		9770	366	"	"
3191	134B	0904	"	"		9779	365	"	"
3192	108B	0904	"	"		9787	366	"	"
3193	153	0905	"	"		9757	363	"	"
3194	159	0905	"	"		9790	358	"	"
3195	148B	0906	"	"		9800	366	"	"
3196	158B	0906	"	"		9788	369	"	"
3197	156C	0907	"	"		9760	361	"	"
3198	165B	0907	"	"		9793	371	"	"
3199	163B	0908	"	"		9798	373	"	"
3200	138A	0908	"	"		9835	359	"	"
3201	142	0909	"	"		9846	369	"	"
3202	127A	0909	"	"		9809	360	"	"
3203	110	0910	"	"		9700	346	"	"
3204	140A	0910	"	"		9834	370	"	"
3205	111	0911	"	"		9804	370	"	"
3206	121	0911	"	"		9804	369	"	"
3207	141C	0912	"	"		9838	362	"	"
3208	101B	0912	"	"		9832	364	"	"
3209	147	0913	"	"		9857	373	"	"
3210	109	0913	"	"		9840	367	"	"
3211	129C	0914	"	"		9812	364	"	"
3212	130A	0914	"	"		9832	369	"	"
3213	151	0915	"	"		9833	370	"	"
3214	132A	0915	"	"		9836	364	"	"
3215	157C	0916	"	"		9832	354	"	"
3216	139B	0916	"	"		9844	362	"	"
3217	104A	0917	"	"		9874	379	"	"
3218	135	0917	"	"		9859	372	"	"
3219	120	0918	"	"		9883	368	"	"
3220	55A	0918	"	"		9820	359	"	"
3221	102C	0919	"	"		9803	366	"	"
3222	149A	0919	"	"		9869	363	"	"
3223	152	0920	"	"		9830	368	"	"
3224	133A	0920	"	"		9834	356	"	"

JEFFERSON PROVING GROUND FIRINGS

LOT PA-E-7145
 DATE OF FIRING 27 Sept. 1961
 FIRING RECORD NO. 144631
 SHEET 6 OF 12

(70°F - Excess Press. Phase)

Round No.	Mfr. No.	Time of Firing	Elev. Mils	Fuze		Mens. Range Yds.	Press 100 PSI	Powder	
				Set.	Act.			Chg. 088.	Lot
3225	253	1100	395	(Inert)		9867	362	47.75	SAJ-15486
3226	365	1100	"	"		9719	344	"	"
3227	249	1101	"	"		9840	374	"	"
3228	369	1101	"	"		9850	372	"	"
3229	201	1102	"	"		9855	375	"	"
3230	374	1102	"	"		9803	367	"	"
3231	293	1103	"	"		9832	343	"	"
3232	355	1103	"	"		9822	369	"	"
3233	255	1104	"	"		9820	370	"	"
3234	256	1104	"	"		9859	370	"	"
3235	270	1105	"	"		9825	371	"	"
3236	247	1106	"	"		9850	369	"	"
3237	295	1106	"	"		9803	371	"	"
3238	273	1107	"	"		9816	370	"	"
3239	291	1107	"	"		9834	371	"	"
3240	228	1108	"	"		9830	368	"	"
3241	346	1109	"	"		UN	361	"	"
3242	304	1109	"	"		9826	367	"	"
3243	319	1110	"	"		9804	364	"	"
3244	391	1111	"	"		9814	352	"	"
3275	313	1130	"	"		9814	371	"	"
3276	236	1131	"	"		9835	371	"	"
3277	277R	1131	"	"		9385	383	"	"
3278	258	1132	"	"		9793	374	"	"
3279	218	1132	"	"		9912	377	"	"
3280	336R	1133	"	"		9360	380	"	"
3281	381	1133	"	"		9885	388	"	"
3282	230	1134	"	"		9843	334	"	"
3283	233	1134	"	"		9901	376	"	"
3284	297	1135	"	"		9850	386	"	"
3285	204	1136	"	"		9844	382	"	"
3286	220	1137	"	"		9858	373	"	"
3287	224	1138	"	"		9850	368	"	"
3288	360	1139	"	"		9792	381	"	"
3289	316	1140	"	"		9844	389	"	"
3290	347	1141	"	"		9868	385	"	"
3291	301	1141	"	"		9837	378	"	"
3292	395R	1142	"	"		9804	361	"	"
3293	364	1142	"	"		9350	390	"	"
3294	367	1143	"	"		9899	387	"	"
3295	265R	1143	"	"		9933	379	"	"
3296	380	1144	"	"		9862	376	"	"
3297	259	1144	"	"		9870	371	"	"
3298	281	1145	"	"		9950	374	"	"
3299	590	1145	"	"		9908	376	"	"
3300	252	1146	"	"		9978	374	"	"
3301	339	1146	"	"		9903	370	"	"
3302	332	1147	"	"		9942	377	"	"
3303	229	1147	"	"		9917	372	"	"

UN - Unobserved

JEFFERSON PROVING GROUND FIRINGS

LOT PA-L-7145
 DATE OF FIRING 27 Sept. 1951
 FIRING RECORD NO. 144531
 SHEET 7 OF 12

(70°F - Excess Press. Phase)

Round No.	Mfr. No.	Time of Firing	Elev. mils	Fuze		Means Range Yds.	Press TCI 100	Powder	
				Set.	Act.			Chg. ozs.	Lot
3304	320	1143	393	(Inert)		9901	373	47.75	BAJ-15486
3305	322	1143	"	"		9810	356	43.00	"
3306	339	1149	"	"		9839	300	"	"
3307	351	1149	"	"		9850	373	"	"
3308	354	1150	"	"		9925	382	"	"
3309	205	1150	"	"		9933	378	"	"
3310	310	1151	"	"		9970	373	"	"
3311	373	1151	"	"		9917	383	"	"
3312	225	1152	"	"		9892	366	"	"
3313	240	1152	"	"		9839	377	"	"
3314	330	1153	"	"		9917	372	"	"
3315	210R	1153	"	"		9975	377	"	"
3316	337	1154	"	"		9957	381	"	"
3317	350	1154	"	"		9972	383	"	"
3318	358	1155	"	"		9960	374	"	"
3319	262	1155	"	"		9939	379	"	"
3320	343	1156	"	"		9900	376	"	"
3321	33	1157	"	"		UN	389	"	"
3322	341	1158	"	"		9862	376	"	"
3323	348	1158	"	"		9808	371	"	"
3324	208	1159	"	"		9875	379	"	"
3325	339	1200	"	"		9877	385	"	"
3326	327	1201	"	"		9836	386	"	"
3327	213	1201	"	"		9852	334	"	"
3328	328	1202	"	"		9845	372	"	"
3329	226	1202	"	"		9849	376	"	"
3330	336	1203	"	"		9849	375	"	"
3331	332	1203	"	"		9784	368	"	"
3332	239	1204	"	"		9860	379	"	"
3333	267	1205	"	"		9849	378	"	"
3334	389	1206	"	"		9884	376	"	"
3335	340	1207	"	"		9868	375	"	"
3336	237	1208	"	"		9872	367	"	"
3337	346	1209	"	"		9854	358	"	"
3338	324	1209	"	"		9814	367	"	"
3339	321	1210	"	"		9837	383	"	"
3340	342	1211	"	"		9844	361	"	"
3341	372	1213	"	"		9876	372	"	"
3342	212	1214	"	"		9878	372	"	"
3343	300	1215	"	"		9814	373	"	"
3344	248	1216	"	"		9830	371	"	"
3345	222	1217	"	"		9850	375	"	"
3346	215	1218	"	"		9874	373	"	"
3347	267	1219	"	"		9899	378	"	"
3348	227	1220	"	"		9950	349	"	"
3349	285	1221	"	"		9912	376	"	"
3350	206	1221	"	"		9901	372	"	"
3351	298	1222	"	"		9890	376	"	"
3352	214	1223	"	"		9912	380	"	"
3353	292RR	1224	"	"		9899	373	"	"

UN - Unobserved

JEFFERSON PROVING GROUND FIRINGS

LOT PA-E-7145
 DATE OF FIRING 27 Sept. 1961
 FIRING RECORD NO. 144531
 SHEET 8 OF 12

(70°F - Excess Press. Phase)

Round No.	Mfr. No.	Time of Firing	Elev. Mils	Fuze		Meas. Range Yds.	Press 100 PSI	Powder	
				Set.	Act.			Chg. ozs.	Lot
3364	372	1225	395	(Inert)		9928	375	48.00	BAJ-15486
3365	282	1225	"	"		9925	370	"	"
3366	250	1226	"	"		10031	372	"	"
3367	314	1226	"	"		9867	349	"	"
3368	294	1227	"	"		9938	373	"	"
3369	396	1228	"	"		9968	376	"	"
3370	284	1229	"	"		9981	361	"	"
3371	251RR	1230	"	"		9906	372	"	"
3372	325	1230	"	"		9955	374	"	"
3373	280	1231	"	"		9822	336	"	"
3374	394	1232	"	"		9978	371	"	"
3375	290	1233	"	"		9968	374	"	"
3376	388	1234	"	"		9953	374	"	"
3377	275	1235	"	"		9959	363	"	"
3378	315	1236	"	"		9939	374	"	"
3379	384	1237	"	"		9921	372	"	"
3380	382	1238	"	"		9968	374	"	"
3381	207	1239	"	"		9985	371	"	"
3382	377	1240	"	"		10001	379	"	"
3383	356	1241	"	"		9985	372	"	"
3384	378	1242	"	"		10084	372	"	"
3385	234	1243	"	"		9928	354	"	"
3386	385	1244	"	"		10101	375	"	"
3387	383	1245	"	"		10083	380	"	"
3388	274	1245	"	"		10051	370	"	"
3389	358	1246	"	"		9971	330	"	"
3390	279	1247	"	"		9978	366	"	"
3391	264	1248	"	"		9366	366	"	"
3392	273	1249	"	"		10001	375	"	"
3393	242	1250	"	"		9941	378	"	"
3394	320	1251	"	"		9971	373	"	"
3395	211	1252	"	"		9905	372	"	"
3396	203	1253	"	"		9914	379	"	"
3397	326	1254	"	"		9899	371	"	"
3398	368	1255	"	"		9888	376	"	"
3399	312	1255	"	"		9899	380	"	"
3400	210RR	1256	"	"		9897	378	"	"
3401	393	1257	"	"		9899	375	"	"
3402	397	1258	"	"		9899	377	"	"
3403	303	1259	"	"		9926	375	"	"
3404	308	1300	"	"		9905	373	"	"
3405	357	1301	"	"		9910	373	"	"
3406	398	1302	"	"		9916	376	"	"
3407	349	1303	"	"		9837	369	"	"
3408	363	1304	"	"		9905	376	"	"
3409	268	1305	"	"		9912	366	"	"
3410	257	1306	"	"		9926	369	"	"
3411	263	1307	"	"		9259	367	"	"
3412	235	1308	"	"		9918	384	"	"
3413	218	1309	"	"		9936	323	"	"
3414	352RR	1310	"	"		9931	377	"	"

JEFFERSON PROVING GROUND FIRING.

LOT PA-E-7145
 DATE OF FIRING 27 Sept. 1961
 FIRING RECORD No. 144631
 SHEET 9 OF 12

(70° - Excess Press. Please)

Round No.	Mfr. No.	Time of Firing	slev.	Fuze Set.	Mens. Range Yds.	Press 501 100	Qdg. oz.	Wt.
3405	397	1311	395	(Inert)	9921	370	42.00	BAJ-15486
3406	379	1312	"	"	9886	387	"	"
3407	392	1313	"	"	9931	378	"	"
3408	361	1314	"	"	9931	380	"	"
3409	254	1315	"	"	9938	384	"	"
3410	363	1316	"	"	9908	376	"	"
3411	231	1317	"	"	9926	370	"	"
3412	344	1318	"	"	9905	376	"	"
3413	289	1319	"	"	9921	371	"	"
3414	271	1320	"	"	9905	376	"	"
3415	318R	1321	"	"	9928	378	"	"
3416	288	1322	"	"	9944	377	"	"
3417	336	1323	"	"	9911	376	"	"
3418	286	1324	"	"	9926	373	"	"
3419	299	1325	"	"	9953	375	"	"
3420	283	1326	"	"	9916	368	"	"
3421	317	1327	"	"	9923	374	"	"
3422	400	1328	"	"	9926	368	"	"
3423	243	1329	"	"	9936	377	"	"
3424	216R	1330	"	"	9893	375	"	"
3425	269	1331	"	"	9891	374	"	"
3426	333	1332	"	"	9860	342	"	"
3427	375	1333	"	"	9971	376	"	"
3428	305	1334	"	"	9947	376	"	"
3429	382RR	1335	"	"	9899	375	"	"
3430	376	1336	"	"	9936	382	"	"
3431	217	1337	"	"	9916	379	"	"
3432	306	1338	"	"	9886	372	"	"
3433	311	1339	"	"	9899	370	"	"
3434	241	1340	"	"	9884	374	"	"
3435	245	1341	"	"	9950	370	"	"
3436	371	1342	"	"	9854	367	"	"
3437	243	1343	"	"	9891	370	"	"
3438	238	1344	"	"	9916	379	"	"
3439	323	1345	"	"	9928	375	"	"
3440	379	1346	"	"	9841	368	"	"
3441	266	1347	"	"	9842	366	"	"
3442	223	1348	"	"	9891	370	"	"
3443	399	1349	"	"	9866	364	"	"
3444	370	1350	"	"	9863	365	"	"
3445	296	1351	"	"	9893	376	"	"
3446	209	1352	"	"	9870	364	"	"
3447	221	1353	"	"	9856	366	"	"
3448	302	1354	"	"	9854	371	"	"
3449	366	1355	"	"	9899	374	"	"
3450	276	1356	"	"	9903	367	"	"
3451	280	1357	"	"	9912	366	"	"
3452	307R	1358	"	"	9866	374	"	"
3453	244	1359	"	"	9884	370	"	"
3454	202	1400	"	"	9897	377	"	"

JEFFERSON PROVING GROUND FIRINGS

(160° Phase)

 LOTS PA-D-6845, and -6847
 DATE OF FIRING 27 Sept. 1951
 FIRING RECORD NO. 114531
 SHEET 10 OF 12

Round No.	Mfr. No.	Time of Firing	Elev. Mils.	Fuse Set. Act.	Meas. Range Yds.	Press PSI 100	Powder	
							Chg. ozs.	Lot
LOT PA-E-6845								
3245	35	1115	395	Inert	9662	386	44.62	PA-B-36502(1P)
3247	53	1116	405	"	9680	387	"	36502(SP)
3249	62A	1117	415	"	9864	377	"	"
3251	49A	1118	"	"	9917	389	"	"
3253	32A	1119	"	"	9896	376	"	"
3255	12	1120	"	"	9975	385	"	"
3257	63A	1121	"	"	9939	385	"	"
3259	46A	1121	"	"	9908	389	"	"
3261	9A	1122	"	"	9872	380	"	"
3263	31	1123	"	"	9968	380	"	"
3265	40	1124	"	"	9901	378	"	"
3267	25	1125	"	"	9956	379	"	"
3269	56	1126	"	"	9910	383	"	"
3271	28B	1127	"	"	9837	371	"	"
3273	22	1128	"	"	9962	378	"	"
LOT PA-E-6847								
3246	145	1115	405	Inert	9668	378	44.66	PA-B-36502(1P)
3248	112B	1116	415	"	9841	380	"	36502(SP)
3250	124A	1117	"	"	9880	391	"	"
3252	117A	1118	"	"	9868	374	"	"
3254	146	1119	"	"	9880	384	"	"
3256	126	1120	"	"	9947	378	"	"
3258	128	1121	"	"	9968	383	"	"
3260	161A	1122	"	"	9878	378	"	"
3262	116B	1123	"	"	9920	379	"	"
3264	164C	1124	"	"	9870	380	"	"
3266	144	1125	"	"	9928	384	"	"
3268	143	1126	"	"	9953	378	"	"
3270	104B	1127	"	"	9814	378	"	"
3272	118	1128	"	"	9872	378	"	"
3274	123	1129	"	"	9962	384	"	"

JEFFERSON IRVING GROUP D FIRINGS

(70°F Phase)

 LOTS PA-E-6846 and -6848
 DATE OF FIRING 27 Sept. 1951
 FIRING NUMBER NO. 144531
 SHEET 11 OF 12

Round No.	Mfr. No.	Time of Firing	Elev. Miles	Fuze Set. Act.	Velocity ft/s	Buzzle Range Yards	Pres. 100	Powder Chg. Oss.	Powder Lot
Conditioning Rounds; Rounds 3455, 3456, and 3457.									
STANDARD ROUNDS:									
3458	67	1454	75		1555	2952	340	44.31	BAJ-15486
3461	89	1456	"		Lost	2952	336	"	"
3464	77	1457	"		Lost	2952	326	"	"
3467	81	1500	"		1543	2976	335	"	"
3470	82	1503	"		1542	3013	332	"	"
3473	82	1505	"		1550	2971	336	"	"
3476	82	1507	"		1547	2997	336	"	"
3479	82	1510	"		1551	2991	343	"	"
3482	82	1513	"		1549	2973	338	"	"
3485	82	1515	"		1547	3000	332	"	"
LOT PA-E-6846									
3459	67	1454	75	S.O. S.O.	1546	2912	325	44.66	PA-E-36602(MP)
3462	89	1456	"	" "	1542	2909	333	"	36502(SP)
3465	77	1458	"	" "	1539	2917	329	"	"
3468	79A	1501	"	" "	1542	2952	321	"	"
3471	81	1504	"	" "	1545	2966	334	"	"
3474	82	1506	"	" "	1541	2926	333	"	"
3477	80A	1508	"	" "	1547	2924	332	"	"
3480	91A	1512	"	" "	1551	2952	334	"	"
3483	66	1514	"	" "	1545	2947	323	"	"
3486	85A	1516	"	" "	1539	2935	328	"	"
LOT PA-E-6848									
3460	191B	1455	75	S.O. S.O.	1537	2885	326	44.66	PA-E-36602(MP)
3463	176A	1457	"	" "	1546	2949	331	"	36502(SP)
3466	183B	1459	"	" "	1545	2966	332	"	"
3469	195B	1502	"	" "	1540	2922	330	"	"
3472	167C	1505	"	" "	1539	2949	332	"	"
3475	169C	1506	"	" "	1543	2933	330	"	"
3478	168C	1509	"	" "	1539	2915	329	"	"
3481	193A	1513	"	" "	1547	2949	331	"	"
3484	175A	1515	"	" "	1546	2920	328	"	"
3487	166B	1517	"	" "	1543	2961	332	"	"

JEFFERSON PROVING GROUND FIRINGS

LOT PA-E-6846 and -6848
 DATE OF FIRING 27 Sept. 1951
 FIRING RECORD NO. 144531
 SHEET 12 OF 12

(-40°F Phase)

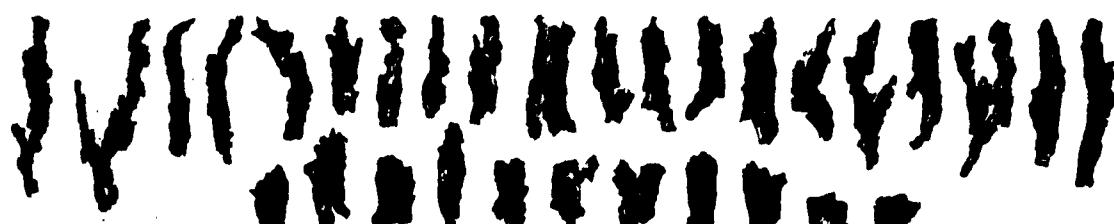
Round No.	Wfr. No.	Time of Firing	Elev. Mils	Fuze Set, Act.	Velocity F/S	Range Yards	Press PSI 100	Chg. lbs.	Powder Lot
LOT PA-E-6846									
3488	83	1518	75	S.2. S.2.	1507	2735	270	44.66	PA-B-36602(LP)
3490	94	1520	"	" "	1504	2775	247	"	36502(SP)
3491	75	1522	"	" "	1507	2790	272	"	"
3494	73	1523	"	" "	1516	2795	263	"	"
3496	88	1524	"	" "	1507	2770	277	"	"
3497	74	1525	"	" "	1509	2833	276	"	"
3500	68	1527	"	" "	1505	2807	251	"	"
3502	92	1528	"	" "	1508	2828	255	"	"
3504	70	1530	"	" "	1512	2841	252	"	"
3506	72	1531	"	" "	1514	2824	253	"	"
LOT PA-E-6848									
3489	189	1519	75	S.2. S.2.	1505	2790	271	44.66	PA-B-36602(LP)
3491	185D	1521	"	" "	1503	2780	265	"	36502(SP)
3493	1728	1522	"	" "	1508	2770	273	"	"
3495	1928	1523	"	" "	1502	2759	264	"	"
3497	1738	1525	"	" "	1509	2802	267	"	"
3499	181	1526	"	" "	1502	2765	265	"	"
3501	188	1528	"	" "	1506	2814	255	"	"
3503	*	1529	"	" "	1496	2765	262	"	"
3505	173A	1530	"	" "	1510	2819	256	"	"
3507	182	1532	"	" "	1508	2828	273	"	"
LOT PA-E-6846 (125°F Phase)									
3508	93	1539	75	S.2. S.2.	1571	3063	363	44.66	PA-B-36602(MP)
3510	90	1541	"	" "	1568	3106	364	"	36502(SP)
3512	95	1542	"	" "	1571	3037	365	"	"
3514	86	1544	"	" "	1568	3049	365	"	"
3516	69	1545	"	" "	1570	3055	359	"	"
3518	76	1547	"	" "	1574	3076	359	"	"
3520	71A	1548	"	" "	1563	3055	357	"	"
3522	84	1549	"	" "	1566	3076	362	"	"
3524	87A	1550	"	" "	1577	3080	356	"	"
3526	78A	1551	"	" "	1568	3059	360	"	"
LOT PA-E-6848									
3509	194C	1540	75	S.2. S.2.	1568	3076	353	44.66	PA-B-36602(MP)
3511	186C	1542	"	" "	1563	3027	354	"	36502(SP)
3513	170C	1543	"	" "	1570	3043	365	"	"
3515	177C	1544	"	" "	1563	3034	363	"	"
3517	174	1546	"	" "	1565	3046	366	"	"
3519	184B	1547	"	" "	1565	3055	363	"	"
3521	180B	1548	"	" "	1569	3063	366	"	"
3523	171D	1550	"	" "	1566	3034	357	"	"
3525	187C	1551	"	" "	1559	3019	355	"	"
3527	179B	1552	"	" "	1565	3037	361	"	"

Gun Crew Foreman: Thomas E. Earls

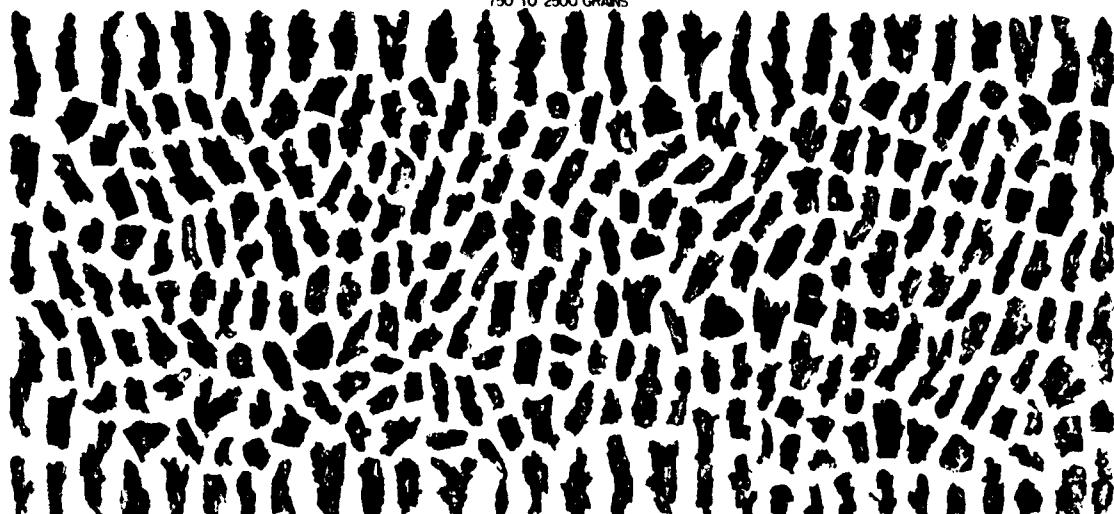
Observers: Chauncey G. Cravens and Charles M. Robertson.

* This sample showed Sample No. 190 RRRRR

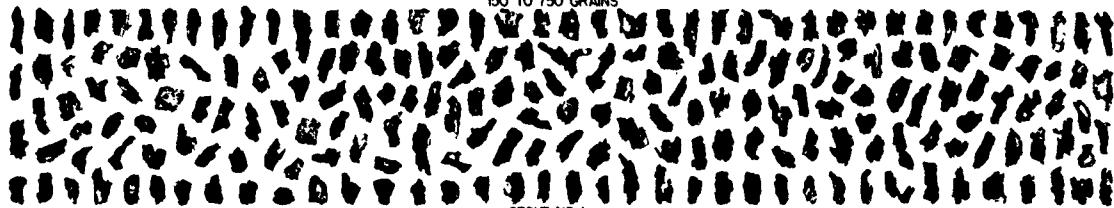
CONFIDENTIAL
Security Information



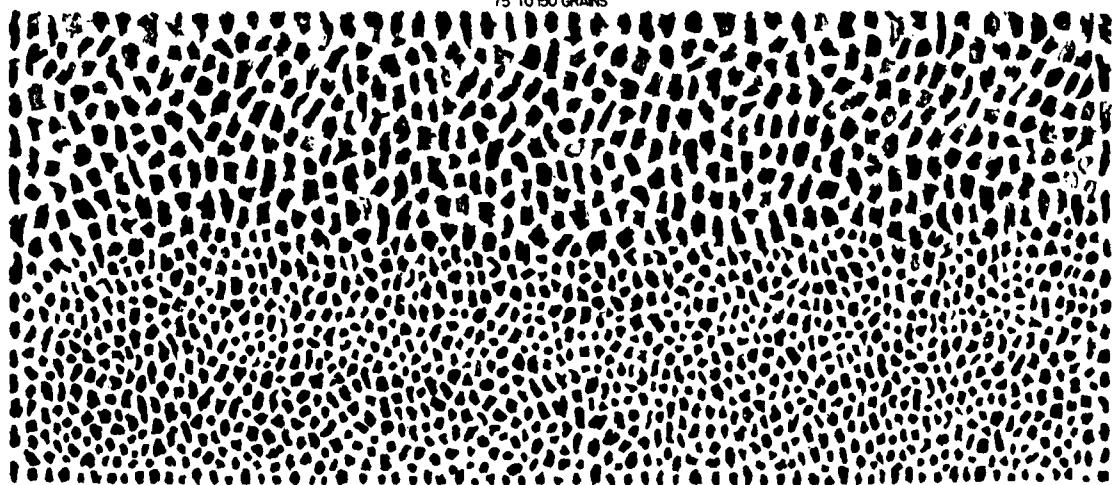
GROUP NO.3
750 TO 2500 GRAINS



GROUP NO.2
150 TO 750 GRAINS



GROUP NO.1
75 TO 150 GRAINS



GROUP NO.0
0 TO 75 GRAINS

CONFIDENTIAL
Security Information



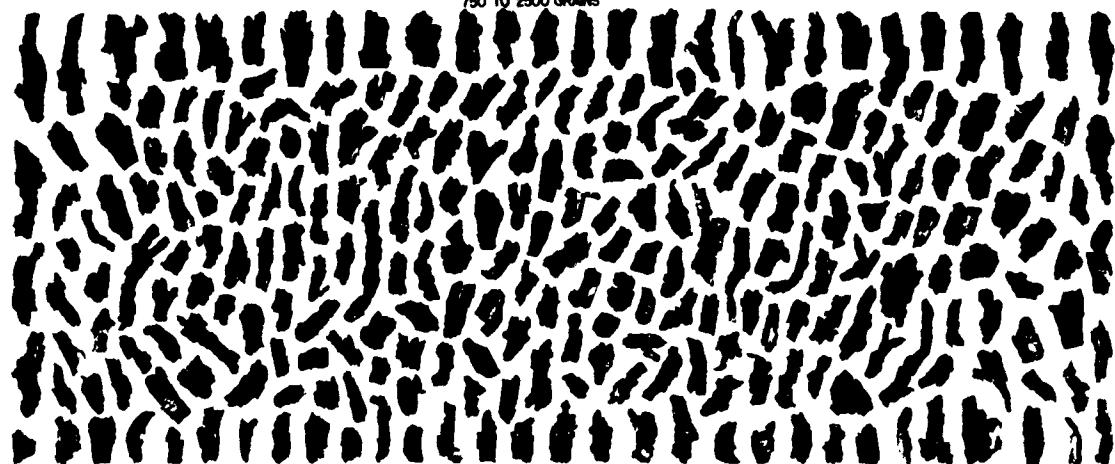
UNFRAGMENTED
SHELL

ORDNANCE CORPS PICATINNY ARSENAL
DISTRIBUTION OF FRAGMENTS OF 105MM
M1 SHELL (LOT LMG-2-1) LOADED WITH
COMPOSITION B (LOT HOL-3-1)
SHELL NO.27 SEPT, 1951 M-39456

CONFIDENTIAL
Security Information



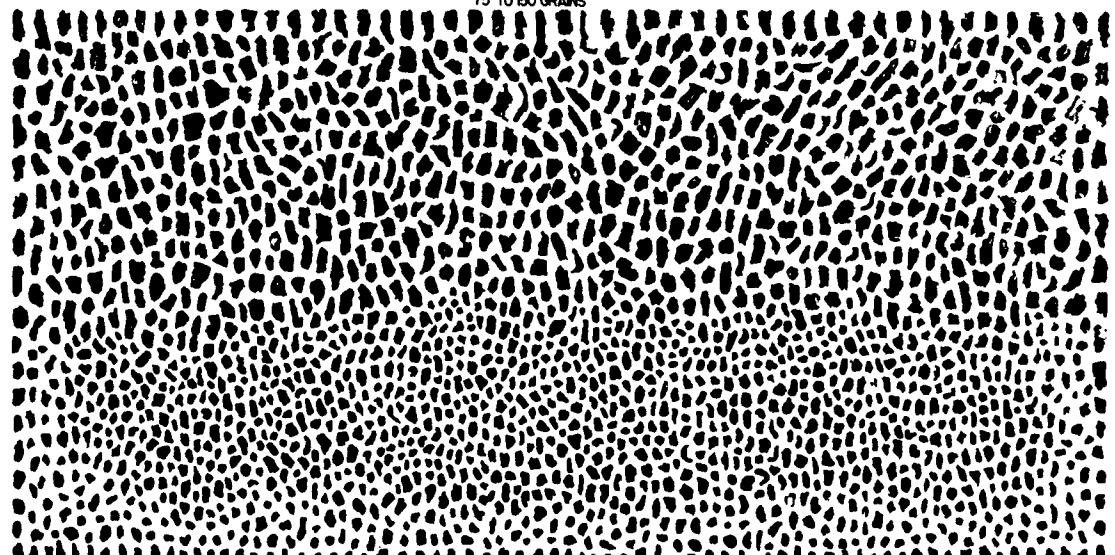
GROUP NO.3
750 TO 2500 GRAINS



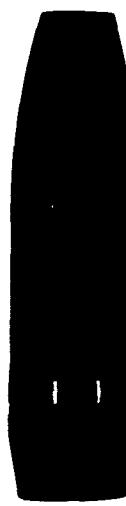
GROUP NO.2
150 TO 750 GRAINS



GROUP NO.1
75 TO 150 GRAINS



GROUP NO.0
0 TO 75 GRAINS



UNFRAGMENTED
SHELL

ORDNANCE CORPS PICATINNY ARSENAL
DISTRIBUTION OF FRAGMENTS OF 105MM
M1 SHELL (LOT LMG-2-1) LOADED WITH
70/30 CYCLOTOL
SHELL NO.16 SEPT, 1951 M-39458

CONFIDENTIAL
Security Information

Security Information

~~CONFIDENTIAL~~
Security Information



UNFRAGMENTED
SHELL

GROUP NO 3
750 TO 2500 GRAINS

GROUP NO 2
150 TO 750 GRAINS

GROUP NO 1
75 TO 150 GRAINS

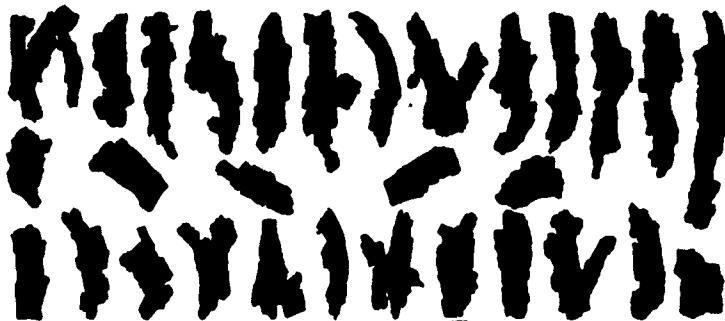
GROUP NO 0
0 TO 75 GRAINS

~~CONFIDENTIAL~~

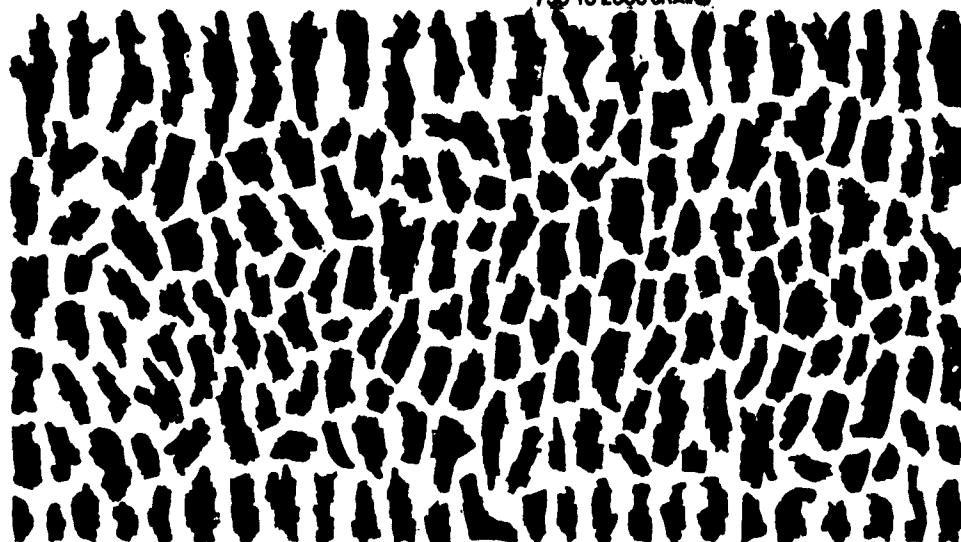
ORDNANCE CORPS PICATINNY ARSENAL
DISTRIBUTION OF FRAGMENTS OF 105MM
MI SHELL (LOT LMG-2-1) LOADED WITH
75/25 CYCLOTOL (LOT HOL-E-5-1)
SHELL NO.7 SEPT, 1951 M-39454

Security Information

CONFIDENTIAL
Security Information



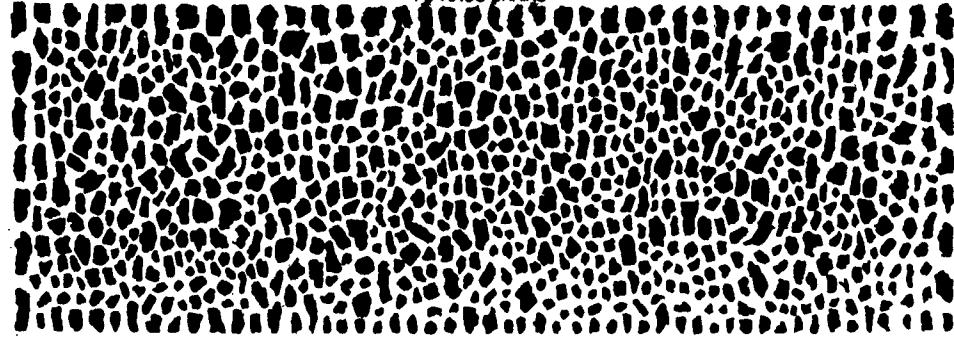
GROUP NO.3
750 TO 2500 GRAINS



GROUP NO.2
150 TO 750 GRAINS



GROUP NO.1
75 TO 150 GRAINS



GROUP NO.0
0 TO 75 GRAINS

ORDNANCE DEPARTMENT PICATINNY ARSENAL
FRAGMENTATION TEST SHELL, HE 90MM M71
COMP B LOADED LOT PAE-T46-377
NO AGEING
MODIFIED M20A1 BOOSTER
SHELL NO.101 APRIL 1946

M-31219

UNFRAMED SHEET

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Security Information

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GROUP NO. 4
2500 GRAINS AND OVER

GROUP NO. 3
750 TO 2500 GRAINS

GROUP NO. 2
150 TO 750 GRAINS

GROUP NO. 1
75 TO 150 GRAINS

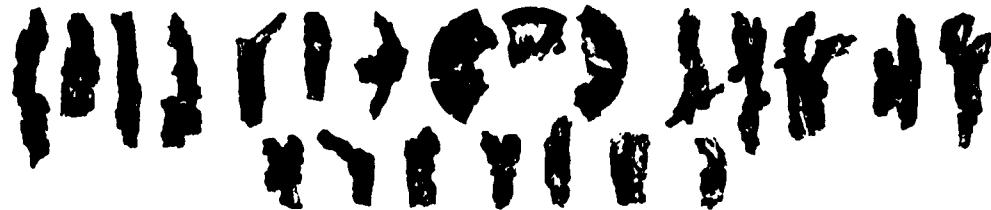


UNFRAGMENTED SHELL

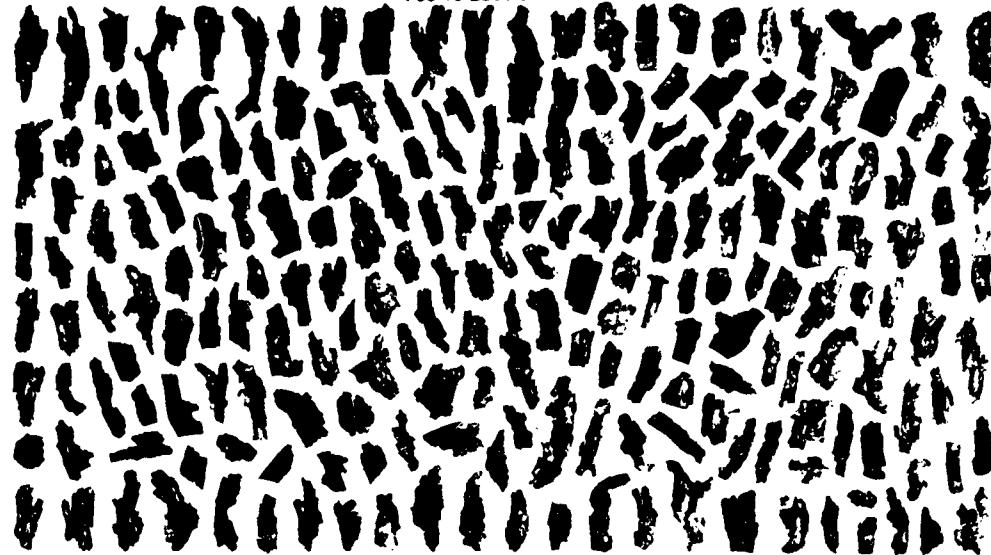
CONFIDENTIAL
Security Information

ORDNANCE CORPS PICATINNY ARSENAL
DISTRIBUTION OF FRAGMENTS OF 90MM
M71 SHELL (LOT WC-91) LOADED
WITH 70/30 CYCLOTOL
SHELL NO 31 JUNE 1981 M-38968

CONFIDENTIAL
Security Information



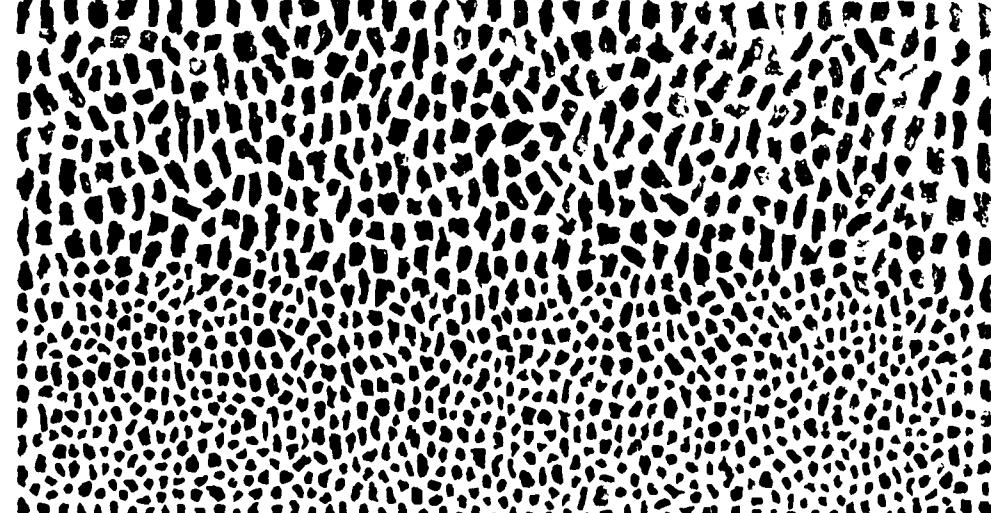
GROUP NO 3
750 TO 2500 GRAINS



GROUP NO 2
150 TO 750 GRAINS



GROUP NO 1
75 TO 150 GRAINS



GROUP NO. 0
0 TO 75 GRAINS

CONFIDENTIAL
Security Information



UNFRAGMENTED
SHELL

ORDNANCE CORPS PICATINNY ARSENAL
DISTRIBUTION OF FRAGMENTS OF 90MM,
M71 SHELL (LOT WC-91) LOADED
WITH 75/25 CYCLOTOL (LOT HOLE-5-1)
SHELL NO 6 MARCH 1951 M-38643